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TREATISE

ON

ARTILLERY.

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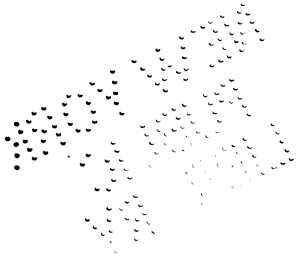

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A

TREATISE

ON

ARTILLERY:

TO WHICH IS ADDED,

A SUMMARY OF MILITARY RECONNOITRING,
OF FORTIFICATION,
OF THE ATTACK AND DEFENCE OF PLACES,
AND OF CASTRAMETATION.

BY H. LALLEMAND,
General of the Artillery of the late Imperial Guard of France.

TRANSLATED FROM THE MANUSCRIPT OF THE AUTHOR,
BY JAMES RENWICK.

VOL. II.

NEW-YORK:
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1820.

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BE IT REMEMBERED, that on the first day of August, in the forty-fifth year of the Independence of the United States of America, H. LALLEMAND, of the said district, hath deposited in this office the title of a book, the right whereof he claims as proprietor, in the words and figures following, to wit:

"A Treatise on Artillery: to which are added, a summary of military reconnoitring, on fortification, on the attack and defence of places, and of castrametation. By H. Lallemand, General of the Artillery of the late Imperial Guard of France. Translated from the manuscript of the author, by James Renwick."

In conformity to the act of Congress of the United States, entitled, "An act for the "encouragement of learning, by securing the copies of maps, charts, and books, to the "authors and proprietors of such copies, during the times therein mentioned;" and also, to an act, entitled, "An act supplementary to an act, entitled, an act for the en-"couragement of learning, by securing the copies of maps, charts, and books, to the "authors and proprietors of such copies, during the times therein mentioned, and ex-"tending the benefits thereof to the arts of designing, engraving, and etching historical "and other prints."

GILBERT LIVINGSTON THOMPSON,
Clerk of the Southern District of New-York.

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CONTENTS OF THE SECOND VOLUME.

This volume contains Military Reconnoitring; a Compendium of Field Fortification, comprising the profile and trace of Lines, Inclosed Works, Intrenched Camps, *Tetes de pont*, and Military Posts; a Summary of Permanent Fortification, including a technical description of the several pieces of the Fortification of a Strong Place, and an inquiry into the utility of Fortresses for the defence of States; The Attack and Defence of Places; Notices of some remarkable Sieges to serve as practical lessons; The Stores, Equipage, and Provisions necessary in Fortresses; The composition of the equipage of Siege Artillery; The preparation of Ammunition and Fireworks; Castrametation, comprehending the general rules for, and the details of the encampment of Infantry, Cavalry, and Artillery, with the precautions necessary to provide for the safety and preserve the health of Camps; and Experimental and Conventional Results.

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A

TREATISE

ON

ARTILLERY.

ON MILITARY RECONNOITRING.

THAT which may be called the "Political and Military Plan" of a war, has for its basis Geography, considered in the most extensive point of view: by which is meant a complete knowledge of the locality; of the political history; of the government; of the military state, both as regards the *personal*, and the *material;* of the public spirit; of the national character; of the manners; of the agriculture, the commerce, and the finances of the country against which it is proposed to act.

The plan of the daily operations of a Campaign has for its basis STRATEGY, The GREAT TACTICS, and TOPOGRAPHY.

STRATEGY is the Science that treats, in general, of the mode of employing troops in the execution of a campaign; that combines and directs the several operations to a determinate object; that anticipates lines of march, camps, and fields of battle.

GREAT TACTICS is the art of managing and combining the various elements of an army, in order to put it in action against an enemy; it is, properly speaking, the art of combats, and of battles.

STRATEGICAL MOVEMENTS are those made upon the great lines of march, which are the foundation of the operations of a campaign, considered abstractedly from the manœuvres of the different arms during the action.

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THE MOVEMENTS OF GREAT TACTICS are those made, during an action, to take advantage of localities and circumstances of the moment.

As for the LESSER TACTICS, they are but a very elementary part of the art of war. They are confined to manœuvres and evolutions, without regard to the ground, or to events; they are the instruction which troops ought to have received before they appear in the field to execute the movements of the Great Tactics.

TOPOGRAPHY consists in the knowledge of local circumstances. It is divided into two branches, General and Minute Topography. The first treats of the chief features of a country, its principal water courses, its great communications, its chains of mountains, &c.; the latter has regard to secondary considerations of a local character. The first sketches the outlines of the map, the second fills up its details.

It is of the last of these branches that we are to treat in this chapter, and we understand by the term "Military Reconnoitring," those inquiries into the subject of local circumstances which are necessary for the conduct of the daily operations of an army.

The business of reconnoitring consists, 1st. in the draught of new maps, or the correction of old ones, so as to represent, in the best possible manner, the form and the nature of a country.

2d. In Descriptive Memoirs, and often in Military Memoirs, in which are discussed the properties of the ground in relation to the marches and movements which may be executed upon it.

Descriptive Memoirs are intended to convey, by a concise and exact description, a knowledge of all those objects which cannot well be set forth upon a map, and of those that cannot constitute a part of it: comprising the nature of the hills, more or less rugged; the nature of the morasses and woods, if they are practicable; the rapidity and depth of rivers, and the nature of their fords, sluices, and piers; the state of the bridges, of the roads, and the necessary repairs; the reasons for preferring one road to others which would lead to the same object, such as the ease of procuring subsistence, and of conducting a march in security; the quality of the lateral communications opening from the great roads; the cantons in which it would be preferable to halt; the population of the villages, and number of labourers they can furnish; the number of horses which the country feeds; the means

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of transportation of every species; the chief commerce of the inhabitants, their industry, habits, and manners. The distances between the towns, villages, post-offices, farms, and other remarkable objects which may serve as rallying points, must also be inserted, and the time, in hours, estimated which will be required to march from one place to another.

"The Military Memoirs that accompany the maps of topographical surveys, should be drawn up by officers skilled in topography, and in the art of war; they should know how to estimate the value of positions, and the strength of posts; they should be acquainted with fortification, and the art of attacking and defending strong places. In these memoirs, it is imagined that offensive and defensive war is alternately carried on in the country, and its qualities for attack and defence are examined under this double relation. The offensive and defensive positions are determined, their good and bad qualities are discussed, and the labour necessary to fit them for each particular object, made known. The intrinsic value of the strong places is ascertained, and their relation to the different military positions, with the means of combining them into one defensive system.

"The points by which positions may be turned, are to be particularly designated, and the mode of occupying these points by intrenched camps, or by redoubts, so as to cover the flanks of the positions, or to connect them, pointed out. The course of rivers is examined, as well as the obstacles presented by lakes, ravines, and broken ground. The places proper for the establishment of bridges, and the works necessary to cover them are marked; and in fine, by considering armies as in motion in the country, it may be proposed to give in detail the chain of operations which might be imagined likely to take place, upon certain hypotheses." (*Gay-de-Vernon.*)

This leads us to present some ideas on what is called the military *coup d'œil.*

MILITARY COUP D'ŒIL.—Two species of this may be distinguished in war: that necessary to the execution of plans, and that which appertains to the conception of them.

The first, which may be called practical, is a faculty by means of which an officer takes, in one comprehensive view, not only the

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form and the topographical and geometrical surface of the country, but in addition, the military properties which it possesses. This sort of the *coup d'œil* is naturally more improved among the inhabitants of mountainous, woody, and difficult countries, than among those who reside in open plains. The latter receive with their impressions nothing but the monotonous idea of a smooth and uniform surface.

Gifted with the practical *coup d'œil*, the officer of infantry, or of cavalry, applies his troops, in some measure, to the ground, and occupies it in the most favourable manner; he measures the distances with his eye, and thus estimates the time necessary to march over them, or to execute any particular manœuvres; the Artillery Officer makes his calculation accordingly, seizes on the points from which the movements of his own troops may be seconded, or hostile dispositions checked and paralyzed, and regulates his firing by the nature of the ground; the Engineer, in fine, judges of the positions favourable for attack or defence upon a line, a frontier, or a whole country; he occupies them by protecting masses, whose figure, extent, and powers of resistance, are in harmony with the nature of the ground, and adequate to the importance of the purpose they are destined to serve.

As to the other species of the *coup d'œil*, which in some measure penetrates into the views, the object, and the plans of an enemy, which inspires those great thoughts that destroy his combinations, and command success, it is properly called a Genius for War. Circumstances develop it in those persons who are endowed with it by nature, but they cannot communicate it to others. They embrace in one view the causes of military operation, their effects, and all the combinations depending on them; the whole is imprinted on their imagination; in the midst of tumult and danger, of deceitful and alarming appearances, and of contradictory conjectures, the man intended by nature for a general, sees by intuition into the projects of his enemy; he strikes, and leads victory captive.

An observer placed in the midst of a great modern European army, is justly struck with astonishment and admiration at the more than human collection of moral and physical faculties which must be concentrated in the person of him whose genius is able to

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conduct these mighty masses to conquest. He sees the reason why nature only produces men of such a stamp from time to time, men whose names serve for epochs in history, and whose genius marks the bounds of human intellect. Nature, in showing herself sparing of such meteors, seems to intimate to the nations that they cannot count upon such prodigies to assert their quarrels. She seems to bid them depend rather upon skill than on genius for the fate of their military destinies. But if rules and maxims are the sole inheritance of skill, they are nevertheless deductions from the labours of the man of genius to direct the man of common mind. If men, whom chance may call to the command of armies, are wanting in the principles of the art, there is almost every chance, that success will incline to adversaries possessed of military information. All things else being equal, the probability is, that victory will rest with the disciplined army.

But we shall finish this digression, and proceed to show in alphabetical order those objects to which the attention of the officer who reconnoitres should be most particularly directed.

ARABLE LAND.

"In reconnoitring this, it will be necessary to remark, if it be cultivated or not, its fertility, its productions, and the time they are collected; the number of bushels of different sorts of grain which it yields, after providing seed, and subsistence for the inhabitants.—The quantity of hay it will produce per acre. The liquors, vinous or spiritous, which are to be found."*

BRIDGES, (*See also* "*Rivers.*")

"Their position, their communication, their dimensions, the materials of which they are constructed, their strength, (if they can bear artillery.) The means of destroying, and of re-establishing them to the best advantage; their relation to the banks, the cur-

* The paragraphs marked with inverted commas, (") are extracted from *L'aide memoire à l'usage des officiers d'artilleric de France*, par le General Gassendi.

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rent, the breadth, and the fords of the river, and to the roads which lead to them.—How their ends may be fortified.—Which bank commands the other.

"In reconnoitring the bridges of towns, villages, &c. remark the streets on each side, the access to, and openings from them, and the adjacent country."

BROOKS AND RIVULETS, (*Creeks, vulgo.*)

"Rivulets, or large brooks, require nearly as much detail as rivers. It is even more necessary to be particular in regard to the depth of water, and in sounding small rivers, than large ones. As rivulets often cover the flanks of an army, all their practicable or frequented passages ought to be well known.

"Their direction; their course; the nature of their beds; their breadth; their floods, and times of drought; their meadows, and the marshes that intersect them; the mills which are upon their banks;* the breadth of their valleys; the hills and ridges which skirt them; the side on which are commanding heights; the tributary rivulets, and the ravines which open into the valley of the stream; the distance between them, that it may be known if they will cover the flanks of an army."

BRUSHWOOD, HEDGES, THICKETS.

"For what species of troops are they practicable, of what nature are the shrubs, the gullies, the brooks, the roads.

(Hedges, such as those of the provinces of Brittany, and Normandy, in France, are good posts, because they furnish parapets of an excellent profile.) The quality of the hedges; they are

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* Mills often render rivers fordable or not, at pleasure, by means of the water dammed up for their supply; it is necessary to know, 1st. The depth of water in their ponds when all the sluices are closed. 2d. What remains in them when all the gates are opened, and the time the water takes to run out. Posts are often preserved or lost in consequence of the state of the water which defends them.

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thin, in poor soil but in rich land thick and formidable obstacles.*

CANALS.

"Their communication; the nature of the ground through which they are cut; the means of draining them, and of turning their courses; their locks, the mode of destroying and of protecting them; how their navigation may be obstructed or defended." (See the article *Rivers.*)

CAMPS, (*Position of.*)

Experience shows, that the chief outlet of an army is that against which the greatest number of precautions are to be taken. Hence arises the necessity of considering the enemy's camp as the centre, and the pivot of all the positions which are to be occupied in his presence. The direction of a camp depends much upon that course which it is supposed probable the enemy will take; it is regulated by the principal outlets through which it is proposed to march against him, or to make a retrograde movement.

The force of a camp consists,

1st. In the advantages of the ground in its front, either for defence or for advancing.

2d. In the length of the march which the enemy would be compelled to take in order to turn its flank.

3d. In the strength of the natural obstacles that cover the flanks.

4th. In the proper relation between the extent of the front and the numbers destined to defend it.

5th. In the number of commodious outlets by which a retreat in several columns may be effected.

6th. In the number and quality of the roads parallel to the front,

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* Brushwood on high ground is practicable at all times, upon low ground the thickets are often marshy. When the sand is of the ordinary colour, the roads are generally good. If the sand be black, or mixed with small white grains, the roads are impassable in winter, and often in time of rain.

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which place all parts of the camp in communication one with the other.

7th. In the sheltered places where the troops that are not in action may be placed to keep them out of reach of the enemy's fire, and which would hide the movements proper to be made in order to reinforce any particular point during a battle.

8th. In the succession of defensive lines which the depth of the camp offers in order to rally and sustain the troops, who might, if formed in one line only, be compelled to abandon their position.

9th. In the facilities the ground presents for the movements of all the arms.

10th. In the nature of the ground in front, or on the flanks, which should not be commanded within cannon shot.

11th. "A camp ought to furnish the troops with a supply of wood and water adequate to all their wants."

Remark the quality of the water, and if it be subject to be dried up. The want of wood or water, or the increased distance of one or the other, renders the other advantages of a position useless. In such a case it is not tenable, but for a very short period, or while the enemy is at a distance.

Springs, rivers, or brooks, in front of a camp, of which the enemy might possess himself, are not to be regarded as a certain resource.

"It would be well to remark, if the difficulty of turning the flanks may be increased by abbatis, or ponds of water; and if the front can be covered by rivulets, ravines, and, in general, by obstacles which would hinder an enemy from marching thither in order of battle. The front must not be covered with obstacles which are insurmountable, and through which an army will have no outlet by which to leave its camp; but there is never any impropriety in the flanks being well covered and so extended as not to be turned without making a great circuit.

"Note must be made of the roads which lead to the front, the flanks, and the rear; of the names, size, and distances of the villages and towns that are in the neighbourhood of the position, and those must be more particularly detailed which lie in front or on the flank within four or five leagues.

"The resources of the country in green and dry forage must

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be particularized, and the quantity of fodder, grain, and vegetables, which that in rear of the camp, within four or five leagues, can furnish.

"In mountainous and hilly countries, it is necessary that the obstacles which cover the front of a position, as well as the defiles by which those obstacles are approached, should be always commanded by the cannon placed on the field of battle at the head of the camp. If these outlets were not protected by the cannon, the enemy might pass them and form without being molested.

"In a level country, where the positions have not the advantage of command, their quality depends entirely upon the nature of the obstacles by which they are covered. It is essential that the ground in front of these obstacles be open, because in placing artillery within reach of them they are defended by it, unless the obstacles are of such an extent as to form long defiles, which may be closed or held with ease.

"The obstacles which impede the approaches of an enemy, are thick woods, through which there are few roads; large rivulets which cannot be forded, and the passage of which requires time to construct bridges; morasses; hollow ways; deep and precipitous ravines; a country intersected by hedges and ditches.

"It is always dangerous to occupy a position which has morasses or marshy brooks in its rear, or ground full of defiles. These, in case of retreat, would render the evacuation of the position slow and difficult. The number of outlets practicable, or which may be made so, for the purpose of passing these obstacles, must be observed. There ought to be five or six of these, so as to have at least three in the rear; one of the centre, and one of each wing."

For an offensive position, upon advantageous ground, outlets of easy passage suffice, but the front must still be covered with practicable obstacles, and the flank rest upon towns, villages, marshes, &c.

A defensive position is only good when the enemy cannot pass by it, nor turn it in force, without exposing his flanks and uncovering his communications. If he can send nothing greater than a detachment into the rear of the position, the front should be of so good a defence as to permit a large detachment to be marched

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against it; in a word, it is necessary that the enemy shall not be able to force you to quit your ground by his manœuvres.

There must be no reason to fear the incursions of the enemy upon the communication with the depot of provisions. If this be too distant, if the intermediate posts be not safe from insult, the position is not tenable. The magazine of provisions should not be farther off than four or five leagues.

CASTLES AND CITADELS.

Their position, their extent, the protection afforded by them to the towns, their object, their connection, their actual strength, and that of which they are susceptible, their means of defence against the country and the towns, the vaults which are in them, and the quality of the arches that cover them.

CLIMATE.

The physical causes which may affect health. The quality of the air, cold, hot, wet, dry, &c. Seasons, whether inclement, and how long so; the means of protection from their effects; custom of the inhabitants in this respect.

COASTS.

"The nature of the coasts, whether lined with sand hills, covered with rocks which render their approach more or less dangerous, or precipices that forbid it altogether. The parts which are open and uncovered, and proper for landing. The bays which form roadsteads and harbours. The points and capes fit for forts and for batteries which may defend the accessible parts; the adjacent islands which may serve as advanced works, to form barriers against the attempts of an enemy. The gulfs, the bays, the roads, the ports. The nature of the winds required to enter or leave these ports, whose advantages and disadvantages must be pointed out. The batteries established for the defence of anchorages and passes. The intrenchments and epaulments constructed in those places where an enemy may attempt to land. The camps and posts intended to cover the principal establishments in the

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interior of the country. Every thing which characterizes the accessible points should be mentioned; the dangers to be met, the obstacles to be surmounted, the means of increasing them, the time of the tide most favourable to approach these places. The places affording the most advantageous positions with regard to the means of defence, and the points to be defended. The actual state of the forts which protect the coast, the batteries, the guard houses, and the artillery in them. The system of defence adopted must be analyzed, improved, or new modelled. The force which the militia can furnish in case of emergency, until troops from particular places shall have time to arrive at the point of attack, must be estimated. If there be rivers emptying themselves on the coasts, the tides are apt to alter their channels; an exact account must be given of this influence.

DEFILES.

"The capacity of their entrances; their length. The posts to be occupied to cover a retreat through them. The nature of the ground at their openings, and how a given number of troops may be there ranged in order of battle."

FORDS.

"A ford for cavalry should not be more than four feet deep, that for infantry not more than three. The form, nature, and level of the banks where the fords are entered and quitted. How are they placed? at elbows, or bendings, and the remarkable points which direct to them; the positions in the neighbourhood by which an enemy may be deceived.* Their bottom. The access to, and opening from them. The depth of water, its rapidity, (if

* Fords impeded by large stones, as they usually are in hilly countries, are troublesome to horses, and impassable for carriages. Those fords are best whose bottoms are of gravel: such are the fords commonly met with among arable plains. In countries of sand, and covered with thickets, the bottom is often a quicksand or a fine gravel; this is dangerous, because, if a large body of horse pass through it, the sand is raised up, the water carries it off, the road is destroyed, and the last comers must pass it by swimming.

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the current be strong, the ford should not be more than two and a half feet deep for infantry,) their direction, their breadth. The means of destroying them.*

It will not do to trust to the country people for the number and quality of the fords. If when the water is low, a stream be observed to flow with rapidity between two banks of sand, it will be proper to sound from one bank to the other, although you know of no ford there, and the people of the neighbourhood are ignorant of any. It seldom happens that in such a case a river is not fordable.

"The surest way of reconnoitring fords, is to descend the river in a boat to which is attached an instrument for measuring depths. If this be placed at a depth of 3 feet in the water, it will show by its motion, whenever it touches the bottom; and thus the extent and quality of a ford may be known.

"Remark the height of the water at the time the ford is first observed; plant a stake, with a scale drawn upon it, by means of which you may see exactly how much the river may have increased or diminished since that period; for it often happens, that in consequence of rains or high winds, a river swells more than a foot in a very short space of time; in that case the ford is no longer passable; if the river has swelled and diminished again, sound it anew, for the rising of the waters may have increased the current, and deepened its bed.

"The best method of securing a ford is to place two rows of posts on its extremities, the whole breadth of the ford, leaving a proper distance between them, and to pass a rope from the one to the other, like a bannister."

FORESTS AND WOODS.

The survey of a large forest consists in the examination of the roads and water courses which traverse it, and in the distinction

* In order to break up fords, place in them several ranges of harrows, the teeth uppermost, fasten these harrows down with pickets or large stones; or else cut down trees, throw them into the ford, their tops to the opposite bank, filling the whole breadth, and if the water be rapid, place the heads obliquely against the current; or, which is best, make a deep ditch the whole breadth of the stream; merely breaking up the entrance with the pickaxe is insufficient.

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between the parts which are full of underwood, and those which are open.

We are easily led to consider great forests as obstacles to the movements of an army; but they are not to be thought such until after they have been reconnoitred with care, so as to ascertain the degree of difficulty which they may oppose to the march of troops.

"Examine carefully their respective situation, their extent, their thickness; the trees, whether fit for fuel or for timber; do their masses form alleys? Their extent, their magnitude; are the woods to the left of them entangled; may they be turned? Is the ground of the forest level, or hilly? From whence do the roads come, and whither do they lead? Their quality; will it be necessary to widen them? Whether it be proper or not to open new routes; can it be done with facility; what direction should be given to them so as not to be taken in flank? The means of intrenchment in the forest, of making abbatis, of taking advantage of its thickets, and of the places which would be opened in making abbatis. The nature of the ground on each side of the forest; does it afford good positions? Its cultivated fields, meadows, ravines, (of the largest of which the bottom must be examined,) and their direction: the streams, the marshes, the springs, the dwellings, &c. The distances of all these objects from the borders of the forest.

"In order to survey a forest in a proper manner, it would be well, if possible, to make the tour of it, to examine if the ravines which intersect it be considerable, and to follow them to their origin, to remark all the roads which cross them, and the swamps which intersect them."

FORTS.

"Their fortification, durable or temporary, low or elevated; if faced in whole or in part with masonry, bricks, or sods; if natural or artificial, ancient or modern. The ground which surrounds them, favourable or not. Their position with regard to the passages by which the enemy may penetrate. The defence of which they are themselves capable, and which they may make if money be laid out upon them."

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HAMLETS.

"The disposition of the farm houses; the ground which they occupy; the mode in which they are built; the aids which may be procured for their defence."

HEDGES. (See *Brushwood.*)

HILLY COUNTRY.

"A hilly country, partially cultivated, and partly wooded, is the most difficult to reconnoitre. It is a country of position which demands minute details.

"Begin the survey at the loftiest part, from which the ravines and waters separate to the right and left. Mark their origin before you proceed to the rest of the details. Follow the principal valleys, the brooks, and the rivers, as far as possible, marking with care the number and position of all the ravines and streams joining that which you are reconnoitring.

"As regards the roads, it must be observed that there are often valleys cut up in such a way by the winding of brooks running from one of their sides to the other, that they are impracticable for troops on account of the number of bridges which it would be required to make. On the other hand, there are few ridges which have not beaten tracks along their whole length; these roads, often little known, and less travelled, are sometimes of great utility.*

"There are some ravines whose outlets are easy of access, whose bottom is a gentle slope, through a meadow dry at least in summer. Ravines of this description will serve for the march of a column. They must be well reconnoitred to note the labour which will make them practicable for any particular species of

* In a country of elevated plains, where two valleys, or two rivers, run parallel to each other, at the distance of two or three leagues, the intermediate space often forms a mountain plain, whose slopes to the right and left are furrowed with hollow ways and gulleys, but whose summit is practicable throughout its whole length. This crest should be well reconnoitred to the very junction of the valleys. It will give a more easy road than the slopes.

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troops, and to show the roads upon which they open. The outlets of these ravines must be guarded against the enemy."

INUNDATIONS.

"The level of the confined water. The operation of the sluices; is their effect speedy? In what time is it estimated that the inundation can be completed? How may the sluices be taken, and how defended? How may their effect be retarded or altogether prevented? How can the inundation be drained? Would it be necessary to raise dykes to insure its permanence?"

LEVEL COUNTRY.

"When this is fertile, it is much cut up. Its hedges, ditches, villages, buildings, brooks, canals, marshes, roads, rivers, bridges, open ground on which encampments may be made, its extent.

MARSHES. (See *Pond.*)

MOUNTAINS.

The surveys of masses of high mountains are not as difficult as those of an ordinary hilly country. In the great chains, the valleys alone are inhabited and passable, so that the examination of the roads and water courses is sufficient, and will dispense with entering into the labyrinth of woods, precipices, and naked rocks, which are found in such a country.

"Distinguish the principal chains which surround a district; the several spurs which defend or weaken the passes. The relative height of their parts. If the chains of mountains are sufficiently extensive to form a system of defence among them, point out the communications, the abbatis, the places fit for erecting redoubts, the roads which should be ruined, and the other means of opposing the enemy.

"The position of the mountains, their slopes, in front and in rear. The means of reaching their summits—the nature of the ground—its figure—are they covered with wood or with bare rocks?—their fertility, pastures, fodder, dwellings, towns, villages, castles, workshops, roads, paths—positions for camps.

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"The mountains which have elevated plains on their summits, are more difficult to observe than others, because the figure of the ground is less strongly marked; they, therefore, require more detail." (See *Hilly Country*)

ORCHARDS.

"To whom they belong?—Are they thickly planted?—Are they enclosed with live hedges, by ditches, with walls, with dikes, with wooden fences, palissades," &c.

PASSES THROUGH AND OVER MOUNTAINS.

If practicable for infantry, cavalry, and carriages. Their direct communications; the communication between them over the summits. The means of guarding them. The time required to ascend them by the roads already in existence. Can new passages be opened?

PLAINS.

"Open plains, rivers, brooks, towns, villages, principal roads, positions. Obstacles of every kind.

"Plains, woody, or partially cultivated, require more detail. Are the trees large or small, their quality, and the extent of the woods.

"Elevated plains, (see *Hilly Country*,) observe with care the roads at the entrances of the towns, villages, &c. which are almost all hollow ways."

PONDS, MORASSES, MARSHES.

"Their cause; is the ground naturally wet? Are they fed by springs? Are they formed by the spreading of a river over firm ground? Their position; how may they be crossed? Are they traversed by causeways; can new ones be built, or old ones re-established? How can these causeways be defended so as to protect or resist the passage of columns? Are there any patches of wood upon them?

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"How are they bounded? What sort of ground succeeds to them in every direction? Are they subject to fogs? At what seasons are they unwholesome? At what time are they passable?* Do they yield turf?"

POSITIONS.

A military position, is the ground which an army may occupy in a country, (for example upon a frontier,) for the purpose of fighting, of preventing the passage of an enemy, of remaining on the defensive, or from which it may march forward to manœuvre against the enemy, and resume what is called the *offensive*. A position must have certain general qualities, and also particular ones relative to the purposes in view. (See the article *Camps*.)

PROFILES.

"In taking the profile of ground, whose details are to be examined, observe those places which may shelter infantry, cavalry, or artillery. Take an account of the ascents and descents, estimated by the time required to march over them."

RAVINES.

The nature of the ground, rocky, loamy, loose pebbles, sand, &c.; can their steep ascents be converted into gentle slopes? Are storms, the melting of snows, &c. to be feared; do the banks cave in?

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* In sandy countries, and those covered with brushwood, there are many marshes covered with water during the winter, which are almost dry in summer: old tracks of wheels may be found through them which should be followed and sounded.

Wet meadows, which sometimes appear solid, will not support a column of cavalry; they should be examined with care, and those meadows whose grass is high and thick, or which have patches of moss of a greenish yellow, are to be mistrusted; they are impracticable for cavalry, and even for infantry, in time of rain.

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RIVERS.

Great rivers form a principal object in all schemes of war. It is essential to indicate all points favourable to the passage of an enemy, and those which are unfavourable to him. The roads which follow the banks, or are parallel to the course of the valleys, ought to be carefully reconnoitred, as also the highways and water courses which terminate upon either bank. The most exact information should be procured on the subject of the periodical floods, and of the strength of the current in times of low and high water.* The number of boats which can be commanded, and the materials for the construction of floating bridges, should be ascertained. The places where an enemy might assemble his portable bridges should be examined, and those in which the means of passage could be prepared, and arranged by your own party. If the enemy have *tetes de ponts*, they must be reconnoitred, and the means of attacking or rendering them useless sought out, or of turning them by passing the river above or below the points at which they are placed.

If we act on the *defensive*, the positions must be prepared which are to be occupied for the purpose of fighting an enemy effecting a passage in such or such a place. The means the enemy possesses of passing the river by fords should be indicated, and the advantages of the bank he occupies. We should also ascertain whether we can guard our bank of the river by military posts. (They should be out of the reach of musket shot, unless covered by intrenchments, and only sentinels placed on the bank.)

If we act on the *offensive*, study what position the enemy might occupy to fight you during or after a passage. Examine if the two banks will permit the establishment of bridges; shun the places where it would require much labour to render the entrance and outlet of the bridge commodious: (for bridges of boats the

* Rivers which rise in high mountains, where the snow does not melt all at once in the middle of the summer, have usually two periodical floods in each year, the first in March or April, when the great mass of snow melts, the other in July or August, when great heats melt what the change of season had left. Rivers which rise in a country less elevated, have no remarkable floods, except in winter, and in the time of heavy rains.

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bank may be as high as ten feet above the surface of the water, but not more than six or seven for bridges of pontoons.)

" It is at the most re-entering part of the bends that bridges are established; the batteries to protect the passage being placed along the shores of the elbows, in such a way as not to be commanded or enfiladed. Avoid those positions where the second bank commands the first; and those where the shallowness of the water would expose the boats to take the ground. If the banks be equally flat, the points of the opposite bank must be marked out where it is the most open and most favourable to the action of artillery. The country upon which you cross should not be intersected by marshes, woods, &c. The neighbourhood of rivers and large streams, whose confluence is upon the hither bank, is favourable for bridges.

" The principal bed of the river should be indicated.* The figure of its banks, its current, its bottom, muddy, covered with gravel, &c., its windings and elbows, and if bridges can be constructed. If it be navigable, and from what place; the tonnage of the boats which it can bear; those which are generally used, and the number it can furnish. At the places fit for crossing, the breadth, the depth, the shores, the roads which terminate at them. The mills that are to be met with, the bridges, the *skows*, the fords. The islands, if inhabited; if cultivated or wooded. The size of the islands, their shores, the command they possess upon the banks of the river.

" The mountains, hills, and ridges which border them, their command, their slope, their form, their distance from the bank. The ravines which reach down to the shore, (these must be ascended to see if they be practicable.) The arms or branches of tributary rivers which are in the neighbourhood, or above the points where bridges may be established.

" Where do the rivers rise, whither do they flow? What is the nature of the country they water; is it our own, or hostile? What resources can be drawn from it before, and during a war? The quality of the water. Does it freeze? Will the ice bear passing

* Rivers which divide into several branches and form islands, are liable to change their principal channels at every flood, which may render one year's survey useless the next.

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upon it? The positions that the ground offers to an army parallel to the river upon either bank.

Note.—In describing rivers, an itinerary, for three or four columns of an army marching along the banks, should be added.

ROADS.

Too much care cannot be bestowed on reconnoitring roads. It is necessary to obtain complete information with regard to them, in order to ensure the success of marches, and to plan the precautions to be observed in executing them.

The following are some of the most essential of these precautions:

1st. That the line of march be covered to the right and left by detachments of light troops, who may observe the country upon the flanks, and keep up a communication between the principal columns that march by different ways toward the same object.

2d. That the itinerary of the columns be so calculated that they shall arrive at a fixed hour at the points where they are severally to display.

3d. For this purpose the time and the means to be employed in surmounting the obstacles the roads may present, should be calculated before hand. Such are bridges broken down; abbatis shutting up the passage; defiles difficult to be overcome by carriages, or by cavalry, &c.

4th. That the positions and strong posts, where the enemy may establish himself to oppose or retard the march, be known.

4th. That the great parks of the army follow the way which is best covered by the troops, and least exposed to the enemy's attacks.

5th. That the dispositions for the march of the several columns be so made that at the end of each day's march, the army may encamp in one general order of battle; that every park communicate with the next, and the whole be ready to act for mutual support.

5th. That finally, whether the marches be in advance or in retreat, the army be divided into the greatest possible number of columns, marching upon all the roads which the country affords, in the general direction of the movement.

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"It will be proper to describe the direction of the roads, their terminations, their breadth, whether changeable or constant. The nature of their soil, whether they are paved, gravelled, or of broken stones. The nature of the ground to the right and left; is it practicable for light troops? The ascents and descents reckoned in hours of march, in what seasons practicable. If bordered with trees, hedges, ditches. The country, rivers, towns, villages, &c. they pass. The roads which meet them; whither they lead. The heights which command them; if overhanging, or if the road wind round them; the parts that are enclosed by banks and hills; where footing is insecure;* the repairs to be made to render them fit for artillery. If they are hollow, for what distance, and the breadth of the wheel tracks of the country. If the road be the only one in the same direction, it must be ascertained if routes for other columns can be opened in relation to it, and their itineraries must be traced."

SPRINGS AND SOURCES.

"The quality of the water—whether easily exhausted. Their use for cavalry. The quantity of water they yield. Their position with regard to a camp. Are you master of the whole course of their stream?"

TOWNS, (*fortified.*)

"Their relation to the movement of armies over the ground on which they are built.

"Their respective and relative situation, whether in the first or second line, &c.; their reciprocal connexion with the neighbouring fortresses. Their own resources, the succours they can re-

* Those roads alone whose soil is of coarse sand, gravel, or stone, are good at all seasons. Those which pass through rich land, between banks, or which are lined or enclosed by hedges, are sure to be bad in time of rain. By-paths must not be neglected; the inhabitants often think them impracticable for troops, in consequence of the ditches and other obstacles which narrow them, but good roads may often be made of them with very little labour.

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ceive in case of attack or siege ; the means of directing these succours according to the direction of the attack. Supplies of provisions, the mode of introducing them. Can they be made valuable as depôts ? Can hospitals be established in them ? Is there a river near them ? Their fortification, in what does it consist ? The detail of the whole circuit, and of each work ; the force of each front ; of that which is attacked. The barracks and storehouses, are there any casemates ? The neighbourhood within cannon shot. (See *Forts.*) What is the state of the artillery, the quantity of ammunition and of provisions ? What will be required in addition to put them in a state of defence ?"

The manner of investing them ; the posts to be connected with the lines of circumvallation ; the manner of fortifying the lines in relation to the ground, to the positions, to the means of attack. The safest communications that can be established between the several quarters, and the mode of cutting them off.

The advantages which the ground between the glacis and the lines offers in opposition to the works of the besieger.

TOWNS, (*open.*)

" Their situation—their construction—their population ;—character ;—religion ;—commerce ;—riches ;—the merchandize in them. The aid which may be drawn from them in men, horses, provisions and liquors. The defence they are capable of; if there be woods or water which will increase the means. Have they old walls, their quality, do the houses rest on them ? Have they gates, and what number : what roads enter them ? The ground in the neighbourhood ?"

VINEYARDS.

" The nature of their soil. Are they planted in furrows ? their depth. Are they supported by poles, by trees, &c. ? Are they surrounded by hedges, ditches, &c. ?"

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VILLAGES.

"Their situation. The number of fires. The nature of the soil—the quantity and quality of the produce. Their markets; the neighbourhood which frequents them. The beasts of burden, the flocks, the beeves and poultry they possess. The arms. The quality of the water; the style in which the houses, the barns, and the sheep cotes are built. The position of the church and burying ground, whether surrounded by walls, by bushes, ditches, or pallisades? The water and wind-mills. Is the village enclosed with a ditch, a hedge, a wall, an earthen parapet; can it be intrenched.

WINTER QUARTERS.

"Consider the means of rendering the communications secure between the quarters of an army. These quarters must not cover too great an extent of country, so that the troops may be within reach of mutual support, and may be re-assembled, if possible, on a field of battle before the enemy can cut them up in detail. Fix the points of assembling. The towns which may serve as magazines; the fortifications they require to guard them against surprise, and to hold out a certain number of days against forcible attacks. The works to be erected in each direction, upon the rivers, the marshes, &c.; whether forts, redoubts, &c. to protect the communications such obstacles might interrupt.

WOODS, (See *Forests.*)

OF DETAILED SURVEYS.

In military operations, geographical maps are consulted to give a general view of a project in relation to the great features, and the principal qualities of a country; but topographical charts are next wanted, in addition to observations made on the spot, in order to plan individual operations according to the accidents and nature of the ground.

When these detailed maps are not to be had, or are incomplete, they must be compiled, or completed. To execute this, a skele-

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ton is taken from a geographical map, that is to say, certain lines which unite the principal points of a country, and the triangles thus formed are filled up by surveys either with the plain table, the compass, or the eye alone. "Surveying with the plain table, which is neither more nor less than a mechanical construction of the projection of the ground upon the plane of the instrument, gives the details of a district with great precision. The advantage of plotting by the compass consists chiefly in the celerity with which the work is performed in the field; but during war, the scarcity of instruments, and the want of time, often prevents the use of these means to fill up the outline. Surveys by the eye must be then made. For this purpose, the triangles which unite the principal places in the country must be taken from a map. The bearings of the great lines which meet the sides of these triangles must then be ascertained by inspection, and their length measured by pacing, the intersections of the water courses, roads, passes, and chains of mountains, with these lines must be marked, and the distances between the remarkable points which serve as checks upon the work, and a guide for tracing the outline, must be reckoned in the several directions which are run over.

"Some principal station must be chosen from which radii may be directed to a great number of objects, orienting* the paper for that purpose, and making use of a ruler as a sight; by this procedure, analogous to those made use of with instruments, the bearings of the points necessary for the map may be got. The distances from the station to the several points may be learned from the inhabitants, and may, besides, be verified by observations from one or more other stations, so that the one shall check and correct the other. While this is doing, the form of the ground is sketched."

If there be no map to give the outlines of the work, the distance between two points whose situations are proper for observation, must be estimated, and the straight lines which unite these

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* For the verb, "to orient," the translator pleads the authority of an able article in the Edinburgh Review, said to be written by the late Professor Playfair, who urges its introduction into the English language, which has no corresponding or even analogous term.—Tr.

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points taken for the foundation of the work. If, from the two extremities of this base the greatest possible number of objects be observed, and the lines on which they are situated traced with a ruler, these two stations will give, first, the situation of all the points near the line from which we commence ; and, secondly, by taking a new station on some one of the lines determined by the preceding operations, new positions may be determined, and so on.

" It is sometimes necessary to construct triangles where the distances can only be ascertained by estimating them with the eye. Then the draught will generally be but vague ; but constant exercise in drawing, and a practised *coup d'œil*, will supply all deficiencies."

OF MEASURING BY PACING.

" In surveys by the eye, all distances are measured by pacing ; and even in surveys with the plain table and with the compass, only the principal distances are measured with the chain, the others by pacing. It is, therefore, very important to know the length of one's step, or in other words, the space which can be walked over in a certain number of paces, as well as the time taken up in passing over the same, or any other known space, so that great distances may be measured by this second method.

" In order to ascertain the relation of the place to a known measure, after having carefully measured a straight line of a given length, march from one end to the other with your watch in your hand, several times, in a natural gait ; then, by taking the mean of the several results, scales may be made both with relation to the number of paces and the time.

" It is not a bad practice, after having tried the experiment on a good road, to renew it during a rain ; to try it upon a meadow, or on arable land, and then to do the same in rising and descending slopes of different declivities, so as to be able to estimate the space described, under different circumstances, with relation to what can be done on a level surface."

It is also very useful to know the pace of a horse which you use habitually, and for that purpose to repeat the above experiments. It has always been recommended to those who follow the career of

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arms, to become familiar with these data, from which advantages may be reaped on every occasion: an acquaintance with them teaches us to estimate distances by the eye alone, which is very important in firing cannon, in the manœuvres of every sort of troops, and to rectify the military *coup d'œil*, without which a commander cannot be sure of success.

THE EXAMINATION OF MAPS.

"After having considered the different means employed to procure the topography of a country, with more or less exactitude, according to circumstances, it remains to inquire in what manner the topographical charts which can be procured, are to be examined and proved.

"If the time permit, the correctness with which the position of the principal point is laid down may be ascertained; but if it be not possible to attend to these details, the different parts of the map must be distributed to experienced persons, who, by passing over the ground within their reach, may judge sufficiently of the accuracy with which the work has been executed, and decide upon the degree of confidence to which the drawing is entitled.

"If circumstances do not admit of employing these methods, there is no other mode of deciding them but by experience. This may be acquired by all who desire it, for it is only necessary to become accustomed to read topographical charts, to make a frequent use of them, and penetrate their views by a comparison of the draught with the objects it is meant to represent. In this way the power of distinguishing false, negligent, or mannered drawings, from those that are correctly taken from nature, is speedily acquired. For example, the banks and sides of valleys commonly correspond in such a way, that the draftsman cannot deviate from their general form without being detected by an experienced eye, and even the figure of minute parts, and partial accidents, produced by similar causes, must every where present themselves under aspects differing only by slight modifications." (*Savart.*)

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OF FORTIFICATION.

GENERAL IDEAS.

Fortification is the art by which the ground occupied by troops is put in a state to resist a superior force, which may wish to dislodge them, or it is the art which enables the weaker party to resist the stronger, and repulse his attacks.

The works which are constructed for this purpose are, in general terms, called *Fortifications*, and the troops protected by them are said to be intrenched.

There are two kinds of Fortification, Field Fortification, which is temporary; and that of fortresses or strong places, which is styled Permanent Fortification.

Field Fortification is that which has for its object the intrenchment of camps and posts, of the passages of rivers, &c. and in general the construction of every work which has relation to the motions of an army in activity. It is usually constructed in haste; it is not complicated: it does not require either the care or the talent necessary in the construction of the other.

Permanent, called also Durable, Fortification, is that which is employed in such chosen positions, as it may be wished to render capable of making the most formidable and longest possible resistance, with garrisons proportioned to their extent. These fortifications are constructed with more care and solidity than the others, and at a time when danger does not press. Of this spe-

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cies, are strong towns, forts to defend harbours, roads, or the outlet of some important navigation, &c.

Temporary Fortification is necessary in offensive war, in order to secure important points of the line of operations, such as passages of rivers, passes of mountains, places of depôt, &c.; to defend ammunition, provisions, and hospitals, from an enemy, or from the population of the country; and to secure the retreat of the army in case of repulse. It is necessary for the fortification of camps, and of those portions of a country where war is carried on; for the defence of parts of a field of battle when they are weak, or to make them tenable by fewer troops, so that the mass of the force may be at liberty to manœuvre upon other points. It furnishes the means of employing stratagem, and of making the most of small numbers. This science is, therefore, of equal importance with tactics.

In a defensive war, Fortification is still more necessary, as we shall see in the sequel, in order to place the force resisting attack on a footing with that which makes it.

CHIEF POINTS TO BE REGARDED IN FORTIFICATION.

There are four principal points to be considered in Fortification, viz. 1. The *Figure* of the works; 2. Their *Command;* 3. Their *Relief;* and, 4. Their *Defilement.*

By the Figure or *tracé*, we mean the combination of straight lines forming different angles which the Fortification describes upon the ground. (pl. 1. & 2. fig. 6, 7, 8, &c.) Much of the force of every work depends upon the more or less happy arrangement that can be given to these lines in relation to each other.

The command of a work is the height of the crest of its parapet above the level of the soil, and the command of one work over another is the difference of the height of their crests; thus, (fig. 5.) *t o*, is the command of the body of the work, or of the crest or magistral *m* above the country, *t y* that of the covered way *c c* above the country, and *v q* that of the place above the covered way. If, then, *t o* be 14 feet, and *t y* 6½ feet, the body of the place will have 14 feet command over the country, and 7½ above the covered way, which will have 6½ over the country.

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The Relief is the height from the bottom of the ditch to the crest of the work, or the command augmented by the depth of the ditch; thus, in figure 5, if *t o* be 14 feet, and the depth *z g* of the ditch 12 feet, the relief will be 26 feet, and the command 14.

Defilement has for its object to vary the relief according to circumstances. It changes the elevation of the magistral or covering lines of works in relation to the neighbouring heights that command their sites, in such a way as to prevent the enemy from having a plunging fire into their interior.

The profile is a vertical section, made through one or several works; (fig. 1, 2, 3, 4, 5, are profiles;) it shows the horizontal dimensions of the parts of works, with their absolute and relative height.

That part of a fortification comprised between two lines, such as *o b*, *o d*, passing through the extremities of the sides of the polygon on which the work is described, and cutting the angles *a* and *e* of the salient into two equal parts, is called the FRONT.

"RASANT FORTIFICATION, or that with grazing fires, is that which has but little command over the surrounding country. The musquetry and cannon fired from its parapets, graze the surface of the ground, and give rise to the name, from the French verb *raser*.

"FICHANT FORTIFICATION, or that with plunging fires, has a great command, and is so called from the French verb *ficher*, because the balls of muskets or cannon strike into the earth, being fired in a direction very much inclined to the horizon.

"REGULAR FORTIFICATION, is that constructed upon the sides of a regular polygon, in such a manner that the fronts shall all have an equal number of works, of which the parts and angles are equal and corresponding to those erected upon the several other fronts.

"It is not true, as might at first appear, that a regular fortification is equally strong upon every front, in consequence of its regularity; or that each front would resist an enemy for an equal length of time. A fortification may be perfectly regular in every

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part, and yet be far from possessing this equality of strength; for the nature and shape of the surrounding country, and the manner in which the relief is managed, will cause great difference in the strength of its several fronts.

IRREGULAR FORTIFICATION is constructed upon the sides of an irregular polygon. A fortification may be conceived extremely irregular, whose fronts shall, nevertheless, be of equal strength. It, therefore, must not be concluded that because a fortification is irregular, its fronts are not in equilibrio as regards the resistance they can make.*

FIELD FORTIFICATION.

OF THE PROFILE OF INTRENCHMENTS.

The object of an intrenchment is to present to an enemy obstacles to be surmounted, and to afford to the defenders the best possible covert from behind which they may make the most advantageous use of their arms. The profile must be planned so as to fulfil these conditions. An ordinary intrenchment is composed of a *Parapet* and a *Ditch*. (See pl. 1. fig. 1. and the following ones.)

Of the thickness of the Parapet.

The parapet is a mound of earth *n b a m d i* raised in front of the position to be defended. Its thickness should be proportioned according to the arms by which it may be attacked.

In ordinary earth

A musket ball fired near at hand penetrates 1 foot, the parapet is made 2 feet thick.

A 3 pound ball	do	3 to 4 feet	do	5 to 6 feet.
A 6 do	do	5 to 6 feet	do	8 to 9 feet.
A 12 do	do	7 to 9 feet	do	10 to 12 feet.
A 24 do	do	12 to 14 feet	do	15 to 18 feet.

A hollow 24 pound ball, or 5 1-2 inch howitz, fired from a short piece, penetrates 4 to 5 feet.

* Traite de Fortification, by Noiset St. Paul, volume 1st.

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The extra thickness which is given to the epaulment above the depth to which the bullet penetrates, is to prevent the interior face of the parapet from being destroyed, and forced in, by the percussion of the projectile. It is evident when cannon cannot be brought to bear on the entrenchment, except from a great distance, the thickness of the parapet may be diminished.

Note.—A 24 pound ball fired into masonry from a very short distance, will penetrate into it 3 feet; therefore, the wall should be built 4 feet thick. If fired in like manner into wood, it will penetrate 3 feet 10 inches, wooden parapets are, therefore, made $4\frac{1}{2}$ feet thick. A 12 pound ball, fired from a distance of 700 yards penetrates 1 foot 7 inches, and a 6 pound ball 8 or 9 inches.

Of the Height of the Parapet.

The height *m h* should be such as to hide and protect the troops which occupy the position from the view and the fire of the enemy. It is usually elevated 8 feet above the ground, to cover the defenders from plunging or *ricochet* fires; some authors allege, that the reason of this height being given, is to shelter the interior of the work from the fire of a man on horseback, which is, however, not so important. When a serious attack is not apprehended, a height of only $6\frac{1}{2}$ feet is sometimes given in horizontal ground, particularly when time presses.

Of the Banquet and Breast Height.

The usual height of a parapet being 8 feet, and a soldier, of the middle size, firing with difficulty over a parapet of the height of 4 feet 6 inches, of the usual thickness and inclination to the horizon, it follows, that in order to fire he must be mounted upon a banquet of such an elevation, that the part *m a* (fig. 2. pl. 1.) of the parapet, between its crest and the banquet *a b*, (which is called the breast height,) may be less than 4 feet 6 inches. It is usually made only 4 feet 3 inches. The height of the banquet of course varies with that of the parapet; but when they are meant to be permanent, 4 feet 6 inches is allowed, because the height will be diminished by the settling of the ground.

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The greatest breadth of the top of the banquet is 3 feet, when there is to be no more than one rank of soldiers; and 4 feet to 4½ feet when there is to be two. This will give them room to manœuvre with ease. In those parts intended for cannon, the banquet must have from 12 to 21, or even 24 feet in thickness, to allow the recoil, and facilitate the management of the pieces. This will vary with the nature and length of the guns, as they may be either field pieces or heavy guns, with travelling or garrison carriages. There must be from 12 to 18 feet of epaulment to each piece. The breast height, for cannon, need not be higher than from 2 feet 6 inches, to 3 feet 10 inches; so that they may fire over it, it is then called *genouilliere*, (fig. 4. *m x*, *x u k*.) These are called *Barbet Batteries*. (See *Construction of Batteries*, vol. 1.)

Of the Slope.

The slope of the banquet should be as great as possible; double its height at the very least, so that it may be easily mounted, and even descended by stepping backwards. It is sometimes cut into steps to diminish its breadth. (fig. 5. *x*.)

The parapet has an inner slope *m a* whose base *l a* is one third of the height *m l* (fig. 2.) This base may be less, but should not be greater; for in that case the soldier, standing too far from the crest of the parapet, is obliged to uncover himself when he raises the but of his musket high enough to fire in the direction of the inclination of the top to the horizon.

When the earth is so loose as to require a greater inner slope, it must be faced with planks, fascines, gabions, or sods, (see *Construction of Batteries*, vol. 1. See also *Exterior Slope of the Parapet* and *Slope of the Ditch*, in the following pages of this article)

The Superior Slope of the Parapet.

"The superior slope of the parapet (fig. 3.) must be inclined to the horizon in such a way that the soldier may see every thing which presents itself in front of, and beyond the outer edge

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of the ditch. It may be observed, nevertheless, that it is not absolutely necessary that this line should pass precisely through the edge of the ditch *c*, but that it may pass 2 or 3 feet above it, as *m t*; for, in that case, the enemy will be exposed to all the fire of the parapet. Its superior slope is often made less in this manner, and for this reason, that if the angle of the crest were too acute like *m c*, (fig. 1.) it might easily be pierced, and overturned by the fire of the enemy, and its defenders exposed. In no case, however, will it do to direct the line of fire higher than the crest of the glacis, or of the parapet of the work it is to defend, for then it will not answer the purposes in view, and the besieger may occupy the interior without fear. All that can be done to remedy such a fault, is to raise the work in front, and lower the one which is behind. (*Savart.*)*

Experience teaches us, that in common parapets from 9 to 12 feet thick, the superior slope is properly inclined when the inner face or magistral line† is elevated 8 feet above the ground, and the outer face $6\frac{1}{2}$ feet. Parapets 6 feet thick have only one foot of slope, so that their outside is raised 7 feet.

The exterior slope *d i*, (fig. 3.) of the parapet, or the *natural slope*, varies with the nature of the soil: its base is equal to its height in common earth; in stiff soil it is only two thirds, or even one half; in loose earth $1\frac{1}{2}$ times the height, and even as great as three times in sand. Thus, the breadth of the base of the outer slope must alter with the nature of the soil, or the works would be soon destroyed by the action of gravity alone. A slope too steep for the soil of which it is made, is also easily beaten down when battered by cannon; but if it be of a proper declivity, the ball will do no more than leave a shot hole.

The quality of the soil on which a work is to be erected, must, therefore, be well studied before the profile is decided upon, in

* The principles and dimensions of Field Fortification are taken for the most part from the Treatise of Mr. Gay de Vernon, and the Elementary Course of Mr. Savart, Professors in the Military Schools of France.

† This is also called the covering line, because it is by its position that the defenders are covered, and line of fire, because it is there that the firing is executed, and upon its length that the quantity of fire depends.

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order that the requisite slope may be given without deviating more than is absolutely necessary from the vertical, which is certainly the best when it can be adopted.

Of the Berm.

The ditch is not precisely at the foot *i* (fig. 3.) of the outer slope, but is distant from it $1\frac{1}{2}$ to 3 feet, so as to obviate the fall of earth, which often results from the action that takes place in recently stirred earth, and to render the construction of the work more easy. This part of the ground, *e i*, which is left between the outer slope of the parapet and the inner edge of the ditch, is called the *Berm*. Where the soil is favourable, it is best to have no berm, as it assists in mounting the intrenchment.

Of the Ditch.

The depth of the ditch is usually not less than $6\frac{1}{2}$, nor more than 10 feet, so that the workmen may dig it, and clear it out with the spade and pickaxe alone, without being obliged to have recourse to other means, which it is difficult to procure in the field.

The depth of the ditch being determined upon, its breadth is calculated so that the earth produced by its excavation may suffice as nearly as possible to the formation of the parapet. It is to be observed that earth newly excavated exceeds its former bulk $\frac{1}{6}$, or in other words, were it returned into the ditch, about a sixth part of the whole would not re-enter it.

The slopes of the scarp and counterscarp vary also with the nature of the soil. In loose earth, the scarp loaded with the weight of its parapet cannot support itself without a slope equal to its height: the slope of the counterscarp need not be more than $\frac{3}{4}$ths of its height. In tenacious soils these slopes need not be more than half the height.

The ditch must not be less than $6\frac{1}{2}$ feet deep, and 9 feet wide. When the ditches are seen and flanked, they may be made wide and shallow; but when the enemy cannot be seen in them, it is better to make them narrow and deep. When it is possible to fill the ditches with water, its depth should be $6\frac{1}{2}$ feet.

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The breadth of the ditch is calculated from the surface of the polygon *n*, *b*, *a*, *m*, *d*, *i*, of the profile of the parapet, whose dimensions are known. This surface should be to that of the polygon, *e*, *f*, *g*, *c*, of the profile of the ditch, as 5 to 6, in order to compensate for the difference in volume before and after excavation. That my readers may not be driven to long calculations, I shall give in the sequel a table to serve for the draught of the principal profiles which may be needed. The profile No. 1, of this table, is employed when it can only be attacked by infantry, or pieces of small caliber, which must batter it from a distance. The profiles Nos. 2 and 3 are constantly used for the construction of intrenchments intended to resist ordinary attacks. The profile No. 4 is only employed for more considerable works, such as *tetes de pont*, and great forts, which may be battered by 12 pounders. A rampart is sometimes added to it, which augments its relief and command. (fig. 5.) The rampart should be from 16 to 24 feet in breadth, *h*, *s*, according to the nature of the gun carriages which are used; but ammunition must then be carried by hand, and 12 feet more ought to be added if it be intended to carry it in carriages behind the pieces. To diminish the breadth of the terra plain, and, consequently, the labour of its erection, stairs are made to mount to the banquet when cannon are not to be placed there, and when it is not necessary that carriages should move upon it.

When intrenchments must be made in the moment of combat, under the fire of an enemy, or to cover ones self quickly in a position about to be attacked, two ditches are made, an outer and an inner one. The inner ditch is only 1½ feet deep, and about 15 feet wide; the outer ditch is three feet deep, and its slope half the depth; the crest is raised within to a height of 6½ feet, and without, to that of 6 feet; the base of the outer slope is made equal to its height; the upper breadth of the outer ditch will he 7 feet, and the lower 4 feet, when the thickness of the parapet is 3 feet.

When it is wished to cover nothing more than a small post of observation, such as a great guard in front of a camp, &c. a simple parapet of the usual breast height is all that is requisite, taking the earth from within and omitting the outer ditch, (fig. 2.)

The height *m h* of the parapet is elevated 4 feet 3 inches, its base is three times the height, the depth of the inner ditch 2 feet, and its breadth at top 14 feet. (*Sayart*, p. 86.)

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Of the Glacis.

" When the work is intended to last for some time, and to make a long resistance, a prismatic mound is usually established upon the outer edge of the ditch as *c q t*, (fig. 4.) which is called the *glacis*. It adds to the force of the intrenchment, inasmuch as it covers by its height the slope *d i*, and renders the descent of the ditch more difficult. The height which may be given to this glacis is not indifferent; this height, added to the breast height of the parapet, should be less, or not more than equal to the whole height *m h* of the parapet; so that the assailant may not be able to have a plunging fire from its crest into the intrenchment. In order to trace it, the base *c t* is sometimes made from 30 to 36 feet, and the line of fire *n o t* drawn, or at others the height *q r* is taken, such that it may be commanded by the magistral of the parapet any given number of feet.

" A species of berm, or covered way *c a q* (fig. 5.) is sometimes made from 6 to 9 feet wide between the counterscarp and the foot of the glacis.

" In order to procure the earth necessary to make the glacis, the ditch is widened or deepened, or else an advanced ditch is dug *t s w*, (fig. 4.) It is proper to take care that the bottom S of this advanced ditch be exposed to the fire of the parapet, consequently, this point S will be nearly in the prolongation of the line *m q*. This advanced ditch serves to hold a row of abbatis, (fig. 35. pl. 3.) By the term abbatis, is meant a range of trees or strong branches, laid side by side, and interwoven. Their roots being placed towards the parapet and well fastened down with pickets. Because these abbatis are not out of the reach of cannon, the earth must be raised before them, forming thus what may be called a second glacis *w v z*, (fig. 4.) with soil taken towards the country still more in advance. It is in like manner proper to be attentive, that plunging fires cannot be made from the top of this glacis into the intrenchment. (*Savart.*)

Before describing the manner of drawing profiles, we shall recapitulate their chief parts. (fig. 4.)

t q c, the glacis.

c g, the counterscarp.

g f, the bottom of the ditch.

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e f, the scarp.
e i, the berm.
d i, the outer slope of the parapet.
m d, the superior slope of the parapet.
m a, the inner slope of the parapet.
a b, the top of the banquet.
b n, the slope of the banquet.
m, the inner crest of the parapet or the magistral.
d, the outer crest of the parapet.
t n, the natural ground.

TABLE OF THE DIMENSIONS OF FOUR DIFFERENT PROFILES.

	No. 1.		No. 2.		No. 3.		No. 4.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.
If the upper thickness of the parapet be supposed to be	3	0	6	0	9	0	12	0
The corresponding dimensions will be as follows, viz :								
Height of the magistral or inner crest of the parapet,	6	6	8	0	8	0	8	0
Height of the exterior crest	6	0	7	0	6	6	6	6
Base of the outer slope, ...	6	0	7	0	6	6	6	6
Breast height, ...	4	3	4	3	4	3	4	3
Base of the inner slope of the parapet, ...	1	5	1	5	1	5	1	5
Breadth of the top of the banquet, ...	3	0	4	0	4	0	4	6
Breadth of the lower part of the banquet, ...	4	5	5	5	5	5	5	11
Breadth of the base of the slope of the banquet, (double the height,)	4	6	7	6	7	6	7	6
Breadth of the berm, ...	2	0	2	0	3	0	3	0
Breadth of the ditch at top, ...	12	9	19	0	21	0	24	0
Breadth of the ditch at bottom, ...	3	0	6	0	8	0	11	0
Depth of the ditch, ...	6	6	6	6	6	6	6	6

The earth in which these profiles are constructed, is supposed to be such as will form a natural slope of 45°, except No. 1, where the base of the slope of the counterscarp is equal to half the depth of the ditch, instead of being equal to the whole depth. If the nature of the soil demand a greater or a less slope, it is easy to make the necessary changes in conformity.

OF DRAWING THE PROFILES.

Let *t n* (fig. 3. pl. 4.) be the intersection of the ground with a plane perpendicular to the direction of the intrenchment whose profile is required, and whose parapet is supposed to be placed on a level and horizontal site. The thickness of the parapet being deter-

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mined, (which we shall suppose 9 feet,) it is set off from h to p, and through these points the perpendiculars $h\ m$ and $p\ d$ are drawn to $t\ n$. If h be the point over which the magistral line is to pass, $h\ m$ must be made equal to 8 feet, and $p\ d$ to $6\frac{1}{2}$ feet. If, then, $p\ i$ be made equal to $p\ d$, $d\ i$ will be the exterior, and $m\ d$ the superior slope. From the point m set off a distance $m\ l$ equal to 4 feet 3 in. for the breast height; through the point l draw $l\ b$ parallel to $t\ n$, and make $l\ a$ equal to $\frac{1}{3}$ of $m\ l$, say 1 foot 5 in.; $l\ b$ or $o\ h$ equal to 5 feet 5 in. which will give $b\ a$ 4 feet. If, then, $o\ n$ be twice $b\ o$ (or in this case $7\frac{1}{2}$ feet,) and the points i, d, m, a, b, n, be joined by straight lines, we shall have the profile of the parapet. And if $i\ e$ be taken 3 feet, $e\ c$ 21 feet, $g\ f$ 8 feet, and the depth of the ditch $f\ r$ 6 feet 6 inches, we have the ditch e, f, g, c.

To proceed to the execution of the work, the plan of the whole of it must be traced at large upon the ground. Pickets of the same height as the profiles of the parapets, are planted upon the lines which represent the edges of the superior slope; these pickets determine the form of the mass as it is thrown up, and serve to direct the work; and they are usually inclined so as to show the extremity of the profile of each face.

As regards the workmen, they are formed into gangs of six men to every six feet of the work, two of them break up the ground with pickaxes, two throw up the earth, and two reduce it to shape. These workmen should be placed at a distance of 3 feet so as not to interfere with each other.

The conduct of the excavation is very important in practice; little trenches are first dug which mark the breadth of the ditch at top and at bottom, and that of the berm; the digging is commenced with the inner ones that correspond with the lower breadth of the ditch, because, if the work were commenced with the width of the ditch at top, the slope would soon be destroyed. The earth first dug out is thrown as far as the place of the banquet, while that which is adjacent to the scarp and counterscarp is kept for their use. As soon as the heap of earth has risen as high as the banquet, the particular construction of the breast height is begun, if it be necessary that it should be in fascines, gabions, or sods.

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OF THE GENERAL PRINCIPLES OF THE FORM OF WORKS.

It is ascertained, by long experience, that soldiers placed in ranks upon the banquet of a parapet, usually fire in lines perpendicular to the direction of the inner crest of the parapet. It follows from this, that if the parapet be in a straight line, the space in front of the ditch will be defended by nothing but direct fires. An enemy marching up to the intrenchment would only meet obstacles directly in his front, which he would take care to lessen by forming in deep column; and when he shall descend into the ditch he will be no longer exposed to the fire of the defenders, and may rally at his ease, in order to give the assault. An intrenchment in a straight line would then be but a middling fortification, and capable of but little resistance; but if the direction T. N (pl. 1. figs. 6, 7, 8, 9. 13. &c.) be interrupted by salient parts, *b c d*, *n o p*, *s t u*, *d e f g h*, *a b c d e*, then the fires from the crest of the parapets *a b c d*, *n o p*, *s t u*, *d e f g*, cross one another in front of the ditch, and the enemy cannot approach the intrenchment without exposing himself to be fired upon both in front and flank at the same time. For instance, in attacking the face *e f*, of the bastion *d e f g h*, (fig. 9.) he will be seen in front by the face itself, and in flank by the flank *b c* of the next bastion. There are then two species of defence in fortification; that of the face, which is called *direct*, and that of the flank, which is called *flanking*. A work is said to flank another when it sees in flank or on one side the way which leads to the other.

Thus the outline of good intrenchments should satisfy two principal conditions; to give such directions to the lines of fire that the balls crossing in front of the position to be defended will produce the greatest possible effect; and to make the passage of the ditch difficult for an enemy.

We have yet to show what are the other principles of the outline, and what are the elementary parts of intrenchments.

"Intrenchments which have been so contrived as to give a variety of figures to the magistral line, are called systems of fortification. In order to trace them, the following principles have been taken as the basis.

"First, the figure of an intrenchment should be such that the different parts of the system shall mutually flank and defend each

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other. Unbroken straight lines, on that account, should be forbidden, and the intrenchment composed of figures alternately salient and re-entering.

No part which is defended or flanked should be farther from that which protects it than 250 or 280 yards, if it is to be defended by musketry, of which that is the greatest effectual range, but if a cross fire of cannon, alone, is to be used for the flanking, and the musketry reserved for the direct fires, the line of defence may be prolonged, but not farther than 5 or 600 yards, which is the greatest range of grape, and the point blank range of ball.

"In the second place, when two parts of an intrenchment form a re-entering angle, for the purpose of mutual defence, the angle should be as near as possible 100°; for if two contiguous re-entering parts of a parapet were to form an acute angle, their lines of fire would be directed against each other, and might injure the defenders; and if, on the contrary, they formed a very obtuse angle, they would not completely flank each other. There would be a space in front of the ditch without fire; for the lines of direction of the fires would not cross but at a distance from the intrenchment varying with the size of the angle. The angle that two contiguous re-entering parts make with each other, is called the angle of defence.

In the third place, the salient angles should not have less than 60 degrees of opening, because, at the summit of too acute an angle, there will not be space enough to execute the manœuvres of artillery and musketry, and because the ground which is not defended in front of the salient, will be so much the more extensive as the angle is more acute; (fig. 6, 7, *x*, *c*, *z*, *x*, *o*, *z*,) and finally, because the salient being more exposed to be battered than any other part, will be easily overthrown, if its thickness be too much reduced. (*Savart*, p. 108. *et seq.*)

Of the elementary parts of figures which are employed in works.

In drawing field fortification, the following figures are used:

The *straight line.*

The *redan*, fig. 6. *b c d.* pl. 1.

Tenails, fig. 7. *n o p*, *p q r.*

Cremailleres, fig. 8. *s t u*, *w v x.*

The *Bastion*, fig. 9. and 12. *d e f g h.*

The *Priest's bonnet*, fig. 13. *a b c d e.*

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The second, third, and fourth of these are nothing more than the straight line broken so as to present points to the enemy to obtain flanking fires.

The bastion is a sort of large redan *c f i*, (fig. 12.) of which about $\frac{1}{3}$ of the face is broken off, in order to obtain the flanks *c d*, *g h*. The angles of the flanks *g h i*, are usually made obtuse, (about 100 degrees,) the flanked angle should be more than 60 degrees.

The priest's bonnet is also derived from the redan.

Arrow. The name of arrow is given to a small redan, detached and isolated, whose faces are not more than 45 to 60 feet, *f*, (fig. 18.) the opening of the flanked angle varies from 60 to 80 degrees.

Lunette. A Lunette is a small bastion detached and isolated, whose faces are from 120 to 150 feet, and the flanks 36 to 50 feet, which is employed in systems in the same manner as the arrow, to fulfil certain particular conditions. See *b* (fig. 17.)

Names of the several works, see pl. 1.

a b, c d, straight lines which are called *curtains*, fig. 6. 9.

b d, n p, s u, d h, *Gorge* of a redan, of a tenail, of a cremaillere, of a bastion.

c, o, q, t, *Salients* of a redan, of a tenail, of a cremaillere, fig. 6, 7, 8.

e f g, k l m, *Salient* or *Flanked Angles*, fig. 9. 12.

i k l, d e f, Angles of the *Shoulder*; they are formed by the face and the flank.

h i k, c d e, Angles of the *Flank*, or of the *Curtain*, formed by the curtain and the flank.

a b, e f, &c. *Faces.*

b c, d e, &c. *Flanks* of the bastion.

s f, u l, &c. *Capitals*, straight lines which divide the salient angles into 2 equal parts.

q d, f c, *The Lines of Defence*; they are drawn from the salient angle of the bastions to the extremities of the flanks, and indicate the direction of the fire made from one part of the work to that which it is intended to defend.

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b c f, *Angle of Defence;* it is formed by the line of defence and the flank.

a f, *Exterior Front;* it is the line which joins the flanked angles.

When the parts of a fortification are disposed in such a way that the defensive fires have, like *t r*, a direction perpendicular to the flanking part *h l*, (fig. 15.) it is named, *Fortification with perpendicular or direct fires.* But if the direction of the defence is such that this cannot take place without the defender being placed diagonally against the flanking part *s g*, it is called *Fortification with oblique fires.*

In the construction of fortification, fires that are too oblique must be avoided, because the soldier almost always fires mechanically, upon what is directly in front of him, leaning upon the parapet without giving himself the trouble to take aim.

OF LINES.

Field intrenchments are divided into two classes:

1st. Those destined to fortify a great extent of ground, to cover a part of a frontier, to shut up the passages by which an enemy could enter unexpectedly into a country, or to cover an army, a camp, &c. The rear of such intrenchments is defended only by natural obstacles, or the disposition of troops. They go by the general name of *Lines.* Of lines some are continuous, and others with intervals.

2d. Works enclosed in their whole circuit, may be employed either individually, or combined together into extensive systems. In the latter case they will serve to fortify a field of battle, a frontier, to close the passes of mountains, &c.

OF CONTINUOUS LINES.

By a continuous line is understood an intrenchment which extends, without interruption, along the whole front of a position. Such lines are made with redans, tenails, cremailleres, or bastions, or they are composed of several of these elements united; for instance, of bastions at great distances from each other, con-

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nected by cremailleres, tenails, or redans, &c. We shall now proceed to treat of those elementary works of which lines are composed.

Construction of the Line with Redans.

To trace a line with redans, upon the straight line *t i*, (fig. 6.) representing the direction of the gorge of the intrenchment, take the parts *e p*, *p m*, &c. 540 feet in length,* at the points of division *e*, *p*, *m*, &c., raise the perpendicular, *e f*, *p c*, *m c*, of 130 feet, which are the capitals of the redans, set off then 90 feet from *e* to *a*, from *p* to *b* and *d* to *c*, and so on for the demi-gorges. Draw the faces *f a*, *b e*, *c d*, and there will remain the curtains *a b*, *d b*. The faces will be about 160 feet, and the flanked angle 68½ degrees, or thereabouts.†

It will be remarked, that (drawing the lines of fire *b m*, *a r*, *f q*, (fig. 10.) through the extremities of the faces *a f*, *b c*, and of the curtain *a b*,) the salients are without protection for an extent of about 120 feet upon each capital, and for the space *f x m* to the right and left of each capital, that the ditch receives no fire, and is without defence, and that the interior of the redans is not spacious.

The weakness of the salient may be remedied by cutting off the angle, or rounding its termination, which will afford some fire in the direction of the capital, that is naturally regarded by the enemy as the weakest point.

This system of redans may be improved by making the demi-gorge 120 feet instead of 90, and the capital 170 feet instead of 130; (fig. 10.) the faces *f a* and *c b* are prolonged, and the straight lines *c h*, *f i*, drawn through the summit of the salients, making the angles *f h c*, *c i f*, each of 100 degrees; or else perpendicular lines are drawn through the capitals *c f*, upon the prolongation of the faces *f a*, *c b*; the faces thus prolonged will give fires *i m* upon the approaches of the ditch of the capital, which was before deprived of them. The interior of these redans is more spacious and more favourable for manœuvres; but the faces

* Formerly 720 feet was taken from salient to salient, but the angle of defence was too open, and the part of the capital left without defence, very great in consequence.

† The measures used are the usual ones of the United States.

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of the redans, as well as the ditches, are still without defence; these two faults may be diminished by breaking the curtain *h i* outwards, and substituting in its place the redan *h o i*, whose fires will take the approaches of the faces in flank, and plunge into the advanced part of the ditches. The system thus amended, adds considerably to the labour of erection, and cannot be employed in all cases.

Construction of the Line with Tenails.

The system is composed of a combination of salients, (fig. 7.) *o*, *q*, in front of a straight line *i t*. To trace these tenails, the gorges *n p*, *p r*, must be taken 600 feet in length, and the capitals *e o*, *m q*, &c. erected upon the middle of the gorges of one third their length, or 200 feet, draw the lines *n o*, *o p*, *p q*, *q r*, which will be the faces. It may be seen, by drawing lines of fire perpendicular to the faces, that the approach to the salient angles does not present sufficient difficulty to an enemy; (there is about 250 feet from the salient to the nearest flanking fire of musketry;) that the faces do not flank each other properly; and that the ditches are not enfiladed. If the angle *n*, *o*, *q*, be made only 100 degrees instead of $112\frac{1}{2}$, which it has in this construction, the faces will flank each other better, the ditches will be better defended, and the capital more completely covered with fire; but the prolongations of the faces are more easily seized upon, and the attack thereby facilitated. This fault is less than the faults of the first construction, unless in the particular case when the prolongations of faces forming an angle of $112\frac{1}{2}$ degrees, cannot be occupied in consequence of some accidental local circumstance.

Construction of the Line with Cremailleres.

To trace cremailleres, (fig. 8.) the fronts *p m*, *m e*, &c. must be taken 360 feet in length, and the perpendiculars *p t*, *m v*, *e f*, raised of 120 feet, then draw the lines *t m*, *v e*, and make the angles *v a t*, *v x f*, from 90 to 100 degrees, or which comes to the same, set off *m u*, *e x*, from 36 to 50 feet in length, and draw *v u* and *f x*.

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In this construction, the salient angles, the ditch in their front, and the approach of the counterscarp, are all defended by cross fires, but all the re-entering angles of the ditch are unprotected, which is likewise the case in all the preceding constructions. It is the more disadvantageous in this one, because, in it the dead angles are multiplied, and are more accessible than in the other systems. It possesses no other good quality than that of advantageously replacing a straight line, in cases where it is impossible to make salient and re-entering angles sufficiently marked; as, for instance, along water courses, and when it becomes necessary to occupy a narrow but commanding piece of ground. Such circumstances will render it of difficult access. It is also used in compound lines combined with other elements.

Construction of the Bastioned Line.

In order to trace this system. Upon a straight line *t n*, (fig. 9.) the parts *a f*, *f l*, must be taken, not less than 600 feet in length, nor more than 800; through the points *a*, *f*, *l*, &c. which are the summits of the flanked angles of the bastions, the capitals *a o*, *f s*, *l u*, are drawn perpendicular to *t n*. That done, there remains to execute upon each of the divisions *a f*, *f l*, &c. the following construction: Bisect the line *a f* in the point *p*, and draw from it the perpendicular *p r*, equal to one sixth of *a f*,* draw indefinitely the lines of defence *a r*, *f r*, upon which are set off the bastion faces *a b*, *b c*, of 180 to 210 feet, or about a third of the front *a f*; through the shoulders *b* and *e* are drawn the flanks *b c*, *e d*, perpendicular to the lines of defence *f c* and *a d*, and through the points *c* and *d*, is drawn *c d*, which is the curtain. If this construction be repeated upon the other divisions, the magistral *a b c d e f g h i* of a bastioned line is obtained.

* This perpendicular is sometimes made only one eighth or one ninth of the front, so that the flanked angle may be as large as possible, in cases where, according to the figure of the polygon, this angle would be otherwise too acute. We shall see examples of this in the bastioned square fig. 25, and the tete de pont, fig. 30.

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If $a f$ had been equal to	720 feet,
$p r$ would have been	120.
$a b$, $e f$, $d e$,	210 each,
The line of defence $a d$ will be	516,
the flanks $b c$, $d e$,	102,
the curtain $c d$,	258,

the flanked angle 143° nearly, the shoulder angle, $a e f$, 127°.

The ditches ought not to follow the direction of the magistral line in front of the curtain, as is indicated at $h i$, because it is evident, in that case, that the musketry of the face $g h$, will not touch the ditch of the face $k l$, except near the salient l, but that the part near the shoulder angle k, will be sheltered from it by the counterscarp of the face $k i$. The counterscarp must, on this account, be in a line drawn touching the circle it forms in front of the flanked angle, from the angle of the shoulder, as is shown. (fig. 25.) But this excavation of the ditch requires a great deal of labour; and where there is neither time nor means to do it entirely, a mass is left $x x$ (fig. 9.) in front of the curtain $c d$, and the ditch of the faces prolonged at their full breadth, in a slope that terminates near the perpendicular $p r$, and is regulated by a line of fire t, drawn from the inner crest of the flank, to the bottom of the ditch of the opposite face.

It will be seen, by drawing the lines of fire, that the faces are perfectly defended by the fire of the flanks, and the ditches likewise.

The faces and flanks of bastions vary in size and direction according to the object in view: 180 to 220 feet, is usually allowed for the faces, and 90 to 120 feet for the flanks. The flanked angle must never be less than 60 degress. It is to be remarked, that if the parts $a f$, $f l$, on which bastions are constructed, were much less than 600 feet, the flanking parts, in the above construction, would be too small, and would have no effect, and if they were more than 800 feet, the lines of defence would be too long to be defended by musketry, for that in the flank would not produce efficacious cross fires beyond the counterscarp of the salient angles.

Priest's Bonnet. (fig. 13.)

To construct this, the gorge $a e$ is made 450 feet, the capital $f g$

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250, and the front *b d* parallel to *a e* 300 feet. The re-entering tenail *b c d* is substituted for the straight front *b d*, making the angle *b c d*, 100 degrees, so that the parts *b c*, *c d*, may mutually flank each other.

This work is usually employed to cover a *tete de pont.*

Of all the constructions we have described, that with the large corrected redans, (fig. 10.) and that with bastions, (fig. 9.) best fulfil the requisite conditions. But the form of the ground, the space, and even the means of execution, will not always permit them to be employed in preference. It often happens that an intrenchment presents to view the union of several different constructions; such lines are called *Compound.*

OF CONTINUOUS COMPOUND LINES.

A continuous compound line may consist in large bastions, or half bastions, distant about 3000 feet from each other, (fig. 14.) and connected by curtains formed into cremailleres; the centre of the front is occupied by a large tenail, *q o h.* In this system, the bastions, which are the principal works, should project far beyond the front of the cremailleres, so as to force the enemy to direct his attacks upon their salient angles, which flank and take in reverse the adjoining parts that flank and defend them in return. In order to construct this system, to a front *t s* of not more than 1100, or less than 500 yards, draw a parallel *v y*, distant 120 feet; take the extreme parts *t m*, *g s*, 120 feet each, and divide the intermediate space, *m g*, into lengths, of about 400 feet, more or less; through the points of division *m*, *p*, *q*, *v*, draw perpendiculars; construct the tenail *q*, *o*, *h*, on the middle one, and draw to the right and left the lines *f p*, *e m*, *d n*, &c.; construct the cremailleres *o u f*, *f x e*, *e c b*, take for the capitals of the bastions twice the distance between the parallel fronts, say 240 feet, and draw the flanks *a b*, *l k.* If it were desirable to make whole bastions, *s z* is made equal to *g s*, and the same construction used, which may be continued as far as the ground requires it.

If there be no more than 600 yards between the bastions, they flank each other perfectly with grape shot, and all the ground in front of the long curtain will be swept by their double fire. But

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when it is not wished to place them so near together, they may be separated 1000 to 1200 yards ; in this way the grape shot will cross upon the middle of the long curtain, and the ground in front will still be commanded, but only by a single fire. The bastions then will flank each other by the fire of cannon balls.

A system composed of tenails, and redans placed upon the re-entering angles of the tenails, (fig. 11.) is also employed. In this system, as the redans are defended by the faces of the tenails, their capitals may be 960 feet apart; for the line of fire proceeding from the middle of the face of the tenail will not exceed 640 feet. This system is constructed by taking the fronts *n p*, *p r*, 960 feet in length, and the capitals *l g*, *n f*, *m o*, *p c*, &c. 190 feet; drawing then the straight lines, *q n*, *n o*, *o p*, gives the faces of the tenails ; in order to trace the redans, the straight lines *f c*, *f a*, *c b*, *c d*, &c. must be drawn through the summits *f*, *c*, *s*, &c. so that the angles *f e g*, *f a o*, &c. may be 100 degrees ; it may also be done by taking *n a*, *n e*, &c. equal to 100 feet, and drawing *f e*, *f a*, &c.

It will be seen that the fires cross upon the capitals, that the parts of the ditch opposite the salients are flanked, but the bottom of the ditches at the re-entering angles is not seen, and the enemy may easily *ricochet* the faces.

A straight line thrown up in haste, may be afterwards covered by detached bastions. It will be necessary, in this case, to see that the bridges of communication from the straight intrenchment to each bastion, be covered by palisaded reducts. This construction is advantageous when water can be introduced into the ditches of the intrenchment, to prevent the enemy from surprising the bastions at the gorge. In any other case, the gorge of the bastions must be enclosed by a palisade that can easily be destroyed when battered from the straight intrenchment.

Of Changes in the direction of Lines.

The development of an intrenchment sometimes requires a change of its direction in conformity to the positions it is to cover. When this change of direction occasions a re-entering angle *a b c*, (fig. 15.) an interval regulated by the range of fire arms, is left between the faces *d e* of the works which regard each other, and the parts *b f*, *b h*, are profiled as usual. If the re-entering angle

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be a right angle, *b f*, *b h*, reciprocally flank each other; but if the angle *a b c*, is acute or obtuse, the fronts *a b*, *b c*, ought to be flanked by a large redan *l m n*, whose faces will respectively be perpendicular to *a b*, *b c*. If the change of direction cause a salient angle, either right or obtuse, *a b c* (fig. 16.) The parts near the summit may be bastioned in such a way that this angle shall become the salient of a bastion, and be thus defended; or the parts may be formed into salients such as S, which can be connected with the general construction. In the case where the salient *a b c*, (fig. 17.) is an acute angle, it is directed that the summit be formed into an isolated work, such as the lunette *l*, and its faces and gorge defended by a bastioned front conformed to the size of the angle, or by a simple tenail. For this purpose, the distances *b c*, *b d*, of between 360 and 450 feet, are set off upon *a b* and *b c*, and *o g*, *o h*, drawn through the points *d* and *e*, making the angles *b d g*, *b e h*, about 100 degrees; the lines *o g*, *o h*, are the directions of the faces of the bastions. From the points *g* and *h*, in opposite directions, the faces, which must be connected with the system of the rest of the line, commence; if a tenail only is wished, *o g*, and *o h*, will be its faces.

In all cases the salients should occupy the elevated points as much as possible, and be placed in advance of the general direction; if they are commanded, they must be defiled; that is to say, the point of the salient must be elevated.

Of Sally-Ports.

In all defensive dispositions, it is indispensable to make passages through the intrenchments *p*, (fig. 18.) or gates to communicate with the exterior, in order to establish systems of guards, and to supply the camp with provisions. They have openings of from 6 to 8 feet. The object of these passages often is, to enable the army that occupies the lines to pass at will from the defensive to the offensive; in this case they must be at least 12 feet wide to be sufficient for the passage of cannon and columns of troops. Two gates, in such cases, are often joined together, so as to leave an opening of 24 feet. These openings are shut by *chevaux de frise*, or by military barriers, of which we shall hereafter speak.

The gate is covered by a lunette or an arrow *f*, whose faces

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reach no nearer the counterscarp than 24 feet, that troops may pass out through this interval. This arrow should contain a post of 12 or 15 men, and the parapet of these little covering works should be kept beneath the parapet of the intrenchments. The precaution of masking all the openings by interior defensive traverses must also be taken. From these the enemy attempting to force the barrier may be fired upon.

The bridges across the ditch are often masses of earth which have been left, but it is safer to dig out all the ditch, and construct a light bridge of rough timber, which may be easily dismounted or thrown down at the moment of attack; small wood and dry brush may also be provided to burn it.

The sally-ports should be always established in the re-entering and best defended parts.

In the construction with bastions and tenails, they are placed in the middle of the curtain.

In that with tenails or priest's bonnets, they are put close to the right or left of the re-entering angle.

In that with cremailleres, they can only be placed at the extremity of the branches, and the covering redan is constructed in the prolongation of the adjoining branch.

Of the use of Continuous Lines.

"It has been proposed by some authors to cover countries of not less than 60 miles in extent, by continuous lines, supported at the two extremities, by places upon rivers, or mountains, which will prevent their being turned. These lines were to be formed of redans at the distance of 300 yards from each other, with a guard of 20 men in each, and a piece of cannon to every three. Reserves of 360 men, and 6 pieces of cannon, were to be provided for every 3 miles, which would require 720 men, and 12 pieces of cannon for three miles, or in all 14,400 men and 240 pieces of cannon, for the guard or provisional defence alone of the 60 miles. The body of the army was to be placed in the rear of the centre, with roads provided to march forward upon to the principal points that might be attacked, and corps placed upon each of the roads as an advanced guard of the army to relieve the points attacked more speedily. Redoubts were to be established upon

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each of the roads between the lines and the body of the army, to rally the troops, and protect their retreat." (*Bousmard*, Vol. 3.)

In the most favourable point of view, when the lines form a semi-circle of 60 miles in extent, at the centre of which the army should encamp, it would have 20 miles to march to reach the point of attack, so that it is probable the lines would be forced before its arrival.

Good redoubts upon the more important points of the country to be covered, and one or more bodies of troops placed behind them, in such a way as to be able to march rapidly against the attack, would be a better defence.

Continuous lines to cover a country are generally composed of farm-houses, morasses, inundations, &c. In fine, of a series of obstacles, easily fortified, and connected together by lines of some one of the above constructions.

OF LINES WITH INTERVALS.

Lines with intervals are those whose course is interrupted by open spaces of greater or less extent, or they consist, simply, in fortified points placed along the line from distance to distance.

Lines with intervals are usually preferred for the fortification of a camp, a field of battle, &c. because they possess the important property, of permitting the party occupying them to pass at once from the defensive to the offensive, if the enemy be repulsed in his attacks, or be routed and broken by the fire of the fortified parts, and it be wished to pursue him. In continuous lines, the troops must defile through narrow passages, which occasions a delay that cools the troops, and lessens their ardour.

Continuous lines have also this disadvantage, that the troops trust too much in them, so that when they are forced in one place, disorder spreads in every direction, and it is believed that every thing is lost; which will not happen in lines with intervals.

In general, therefore, points fortified by redans, lunettes, or redoubts, placed skilfully, and combined with the plan of battle, are to be preferred. This does not altogether exclude continuous lines. There are cases where troops ought to rest rigorously on the defensive; for example, if they have an important passage to defend, a siege or operation to cover, or if they are so inferior in

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number or discipline to those attacking, that they cannot leave their intrenchments without imprudence, to charge an enemy who is their superior. It is evident that in such cases intervals that cannot be useful need not be left: intervals would besides enable the enemy to penetrate more easily, and to attack the defenders man to man. Such intrenchments should then be of equal strength along the whole line, furnished with abbatis, &c. and difficult to force. There may be besides good redoubts behind these lines to serve as points of support for the reserves, and as a retreat for the troops in case of need.

OF THE INTRENCHMENT OF CAMPS AND FIELDS OF BATTLE.

The Camp of an army is placed, whenever it is possible, in a position whose front is covered by obstacles, such as brooks, ravines, &c. and flanked by woods, marshes, &c. Such positions cannot be always found, or if found, they must be strengthened by intrenchments. The camp must, in that event, be fortified by redans, lunettes, detached bastions, &c.

When the camp is pitched in the presence of an enemy, and the intrenchment must be made during the night, fortifications of easy execution must be employed, presenting salients from distance to distance, connected together by lines which are proof at least to grape shot, musket balls, and the bayonet. "To fortify thus in a single night, the front and flanks of a camp or position, General Rogniat proposes to cover the extent of the front by bastioned redoubts, 250 yards distant, from salient to salient. These bastions should be united by a trench with a banquet, like a parallel in a siege, which shall extend from the extremities of the flanks to the point of intersection of the lines of defence, in the form of a broken curtain, defending the redoubts as directly as possible, without masking the fire of their flanks. Passages should be left between these parallels and the flanks, 10 yards wide, for the sorties of cavalry and artillery; as for the infantry, it may sally out in order of battle, by passing over the parapet of the trench, which for that purpose may be furnished on the inside with steps made of fascines. A redoubt must also be raised on each curtain to reinforce the weaker parts. The bastions of the front

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will flank each other within musket shot, and are separated by intervals of 130 yards, that are defended by their fires, and those of the adjacent bastions.

"Fifty yards must be allowed for the length of the faces, and 36 for that of the flanks; the inner crest of the parapet will be 6½ feet above the soil, the banquet 4 feet 3 inches below the crest, and 4 feet wide; the parapet 4 or 5 feet thick at top, and the superior slope 1 foot; the ditch 6½ feet deep.

It will be easily seen that such intrenchments may be erected in a night. For instance, in a camp of 30,000 men, in two lines, having 9 redoubts to cover the front, and 2 upon the flanks, which will contain 1,800 yards of bastioned intrenchment, and 1,000 yards of trench; 5,000 men will suffice to complete the work in six or eight hours.

This camp may be afterwards strengthened, if it be thought proper, by pallisading the bastions, and placing abbatis at the bottom, and in front of their ditches, in making *trous de loup*, &c.

It is evident, that in order to execute these defensive works with the requisite dispatch, it is indispensable that each soldier carry a pioneers tool, wrapped in a leather case, and suspended to the knapsack. (*Considerations sur l'art de la guerre, by Lieut. Gen. Rogniat.*)

Of the Front covered with Lunettes.

To fortify the front of a position by means of detached lunettes, the front *t n* (pl. 2. fig. 19.) must be divided into equal parts *a b*, *b c*, &c. of 250 to 320 yards in length,* and the intervals bisected; draw the perpendiculars *m n*, *m n*, through the points of division upon *t n*; make *m n*, *m n*, greater than *a m*, *m b*, or a little more than half the front, and join the points, *a*, *n*, *b*, *c*, by the lines *a n*, *n b*, *b n*, *n c*, these straight lines are the directions of the magistral. The flanked angles *d a e*, *f b g*, *h c i*, are greater than right

* If it is not wished to make use of the cross-fire of musketry, but of cannon only, the salients may be at the disiance of 700 yards, which is the range of grape shot, or of 1400 to 1600 yards, so that the fire of grape will meet midway.

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angles. In order to obtain the faces of the lunettes, take *a d*, *a e*, *b f*, &c. each equal to from 40 to 50 yards. Before drawing the gorges and the flanks, *a' o*, *o b'*, &c. must be drawn parallel to the magistral lines, and at such a distance as to represent the outer slope or foot of the counterscarp, and having made *a k*, *b l*, *c p*, &c. 60 yards in length, thes traight lines *k b'*, *a' l*, *l c'*, will be the directions of the demi gorges, to which the perpendiculars *d a*, *e r*, *f x*, &c. must be drawn, which will be the flanks.

The defence may consist in these first lunettes alone, but in order that the salients may be more difficult of access, a second line *x*, *x*, is established, whose pieces should flank those in the first line. The faces of these second lunettes are also about 40 yards in length, and perpendicular to the first.

A third line of redans *y*, *y*, *g*, is sometimes established, whose faces are made at least 30 yards in length.

In order that the ditches of advanced works may be defended by the fire of those in the rear, they must be prolonged in a straight line opposite the flank, and conducted in a slope beyond the line of the gorge, instead of making them follow the magistral of the flank. To prevent the enemy from entering these lunettes at the gorge, it must be closed by a row of palisades. Toward the middle of the gorge a passage is left which is defended by abbatis, or other obstacles. If the gorge were defended by a parapet, the enemy would be covered by it when he had penetrated into the work, instead of which palisades can be destroyed by the fire of cannon, and then the enemy is without shelter.

When it is wished to cover more ground with the intrenchment, it may be composed of a central redan, and two branches in the form of *cremailleres*.

To fortify the front of a position in this manner, square redoubts are sometimes made, and in order that they may flank each other, one of the diagonals is placed upon the capital.

When cavalry is to be placed in a defensive attitude, epaulments *r* should be erected 9 feet in height, behind which it is sheltered until it can enter into action, instead of being uselessly exposed to the effects of artillery.

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Of a Field of Battle.

Only the most important points are usually intrenched, such as those before a passage which must be defended, or in the weaker part of a line of battle, where the troops are deficient either in quality or numbers, in consequence of the collection of the greater part of the élite upon another point where it is to act offensively. These intrenchments should be capable of resistance with a small force.

OF ENCLOSED WORKS, REDOUBTS, &c.

When works are intended to fortify isolated points which may be surrounded by the enemy, they ought to be enclosed on every side, for the safety of the troops, and constructed in such a manner as to facilitate their defence, whatever may be the direction of the attacks.

Redoubts and *Fortins*, or field forts, are intrenchments of this sort. Their object may be to close or command an important pass, to cover the weak part of a position, or protect one that might be advantageous to the enemy. These works may also be employed to fortify a system of chosen positions.

Of Redoubts.

Every work closed and intrenched upon its whole circuit, the capacity of which is not great, and whose figure is such as to produce direct fires only, and none flanking, is called a *Redoubt*. These redoubts may have figures of all sorts, but although with equal circumferences, the redoubts which have the greatest number of sides, are the most capacious; and though the most capacious, with equal circuits, are, *cæteris paribus*, the best; redoubts are, notwithstanding, usually made square. (pl. 2. fig. 20.) These have fewest salient angles, which are the usual points of attack in consequence of their weakness. The circular redoubt is advantageous on account of the size of the enclosed surface, but it produces a resistance equal in every direction, while it rarely happens that it is not necessary to direct as much fire as

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possible upon some particular point. This figure is, therefore, rarely employed.

Of the Capacity of Redoubts.

The capacity of a redoubt ought to depend upon the force of the detachment it is intended to contain. For example, a square redoubt, whose sides are ten yards each, cannot contain the 40 men necessary to line its parapet, at the rate of only one man for each yard of the parapet; for the side of the inner square, forming the terraplain, $x\ x$, (fig. 20.) will be less than 10 yards by all the breadth of the two banquets and their slopes, or not more than 4 yards at most. This will give 16 square yards of surface, but as a yard square of surface is necessary for each man, there will be 24 men who will have no room.

If the length of the line of fire of the redoubt be too great for the number of men it can contain, it follows that the parapet will be ill defended.

The weakest defence of an intrenchment, requires that the parapet be lined with soldiers in one rank, three feet apart; but this defence does not afford a sufficiently lively and sustained fire, To make a good defence, the parapet should be lined with two ranks, and there should be, besides, a reserve of not less than an eighth, or even a fourth of the combatants. To make the defence complete, the reserve should be so strong as to be able to sustain the defenders of the parapet, and repulse the enemy on every side at the point of the bayonet; it should, for this purpose, be about half the number required to line the parapet in two ranks. When there are men enough, they are placed in two ranks two feet apart, and each man can still easily manage his piece; this is better than putting them in three ranks three feet apart.

Since the least redoubt should have its parapet lined with at least one rank of men, it follows, that that whose side is 13 yards is the least which ought ever to be made, for it will have 49 square yards within its banquet, which will lodge 49 men, and will require 52 men for its defence.

The redoubt, with a side of 16 yards, can lodge 100 men within the banquet, while 64 men will suffice to line its parapet in one

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rank 3 feet apart, so there will remain a reserve of 36 men, or the parapet may be lined with one rank of soldiers two feet apart.*

The first redoubt which fulfils the conditions of a good defence, is that with sides of 20 yards. It will contain 196 men, after allowing 8 yards for the banquets and their slope, and has need of only 160 to line its parapet in two ranks three feet apart; while a reserve of about 30 men would remain.

The redoubt, with sides of 26 yards, will contain 324 men; they may be formed two deep, a file to every yard, and a reserve of 116 men left; or cannon may be used if the reserve be diminished.

The redoubts, whose sides are 32 yards, will contain 576 men, so that, if the parapet be lined two deep, at the rate of a file to every yard, there will be a reserve of more than 300 men. In this case the parapet may be lined with files two feet apart, and there will be still a reserve of near 200 men, or cannon may be introduced without injuring the quantity of the defence produced by fires of musketry.

The largest redoubt usually made, has sides of 40 yards. It will contain 1024 men; but as no more than 320 are required to line the parapet in two ranks, there may be a very strong reserve, and cannon placed without diminishing the number of defenders.

To determine the size of a square redoubt to contain a given detachment intended for its defence, observe the following rules:

If the detachment be from 50 to 70 men, a fourth of the number of men will give the length of a side of the magistral, or inner side of the redoubt, in yards. The men will be formed in one rank.

If, from 70 to 90 men, substract one fifth for the reserve, and take one fourth of the remainder for the side of the redoubt.

from 90 to 120 men, substract one fourth for the reserve, and take one fourth of the remainder.

from 120 to 150 men, substract one third for the reserve, and take one fourth of the remainder.

from 150 to 200, divide by eight for the length of the side, the men in this case are formed two deep.

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* It must be observed, that the surface within the banquet diminishes when an interior traverse is made to mask the passage, instead of an outer redan.

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from 200 to 300, take one fifth, one fourth, one third, for the reserve, according to the force of the detachment; one eighth of the remainder is the side of the redoubt.

from 300 to 400 take one twelfth for the side of the redoubt.

When cannon are to be used in the redoubt, no fixed rule can be laid down, so as not to have a space either too little or too great. The terraplain increases in a proportion very much greater than that of the inner side, as, in doubling it, the surface of the terraplain is quadrupled. Thirty-six square yards at least must be allowed for each gun and its accessaries; 12 to 18 feet of parapet must be allowed in length for each piece, and 12 feet at least in breadth for field pieces, which must be increased up to 21 or 24 feet, if they be pieces of large caliber, mounted upon siege or garrison carriages. The breadth of the ramp to mount to the platform, should be 12 feet, and its slope at least six times its height.

The profile of a redoubt, as well as that of lines, should be governed by the nature of the attack it may have to sustain. When nothing but musketry is to be feared, the parapet may be made of the least thickness. If it can be battered by cannon from a great distance only, the thickness may be less than when they can be brought near. It must also be in proportion to the calibers which may be feared. *See the profiles of the foregoing table, or the figures* 3, 4.

Of Communications with the outside.

Upon the faces least exposed to be insulted by the enemy, a passage of 12 feet wide is left in the parapet where guns are to pass, or three feet wide when infantry only. Sometimes a corresponding mass is left in the ditch to serve as a bridge, but it is better, for safety, to dig out all the ditch and make a bridge of wood, which may be burned at the moment of attack, or whose materials may serve to fortify the passage. When there is no artillery or carriages to introduce into the redoubt, but soldiers only, ladders may be made use of instead of a passage in the parapet.

The opening is closed by a barrier, and covered by a small redan, leaving a passage of 24 feet between the extremity of its

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faces and the counterscarp. (fig. 18.) When the redoubt is sufficiently large, an interior traverse is made, instead of the redan, which has inconveniences. This traverse is made of trunks of trees, when they can be got, and they must be a foot in diameter if they can be battered with cannon.

Faults of the Square Redoubt.

The square redoubt has a sector upon each capital, that is without any direct fires, (like *b d*, fig. 20.) and, in consequence, defenceless; its ditch is not flanked, and is, therefore, without defence. From this it results, that an enemy may arrive in the ditch, without experiencing any great loss; he is then in safety, because he is not seen from any part of the work.

To remedy this first fault, all the angles are rounded so that soldiers may be placed in them. If there be cannon, the corners of the angles where it is to be placed, are cut off, so that they may fire upon the sector which is deprived of the fire of musketry.

In order to defend the ditch, a species of reduct may be established at right angles to its direction, formed of two ranks of palisades touching each other, with loop holes to fire in the direction of the ditch. These two rows should be six feet apart, and covered with beams, fascines, and earth. (See the description, p. 8. and figure 38.)

In order to bring fires to bear upon the ground in front of the capitals, two or three *cremaillere* teeth, *e*, *o*, three feet each way, must be made; one side of which is perpendicular, and the other parallel to the salient capital. By this plan, there will be a fire of musketry upon the sector. Several engineers have proposed the idea of cutting the whole magistral line into the form of cremailleres, but this method is not so good as it first appears. The lines of fire of the flanks *e m*, *e n*, cannot have the height necessary to batter the counterscarp, and will strike the ground at too great a distance for that purpose. The soldiers placed in contiguous teeth cannot fire at the same time in consequence of their arms crossing each other. This method must not, however, be entirely rejected; 3 or 4 cremailleres to the right and left of a salient angle, may produce, upon the capital, the good effect of alarming the enemy, who will think himself safe in following its direction.

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Interior reducts made of the trunks of trees, (cut into loop holes,) serve also for traverses and *paradoses*, augment the defence considerably, and prevent the enemy from maintaining themselves in the redoubt after they shall have entered it. Redoubts of 32 yards square, and upwards, have an interior space which permits the use of these reducts. (See their construction hereafter.)

Of the use of Redoubts.

Redoubts are of great use in war; they defend posts, passes, fords, and communications of every sort. Particular positions in fields of battle are occupied by redoubts, either to reinforce a weak part of the line, or to occupy the attention of the enemy so as to be able to manœuvre in another direction, &c. The celebrated redoubt of Montenotte is a remarkable instance; it was guarded by 1,500 grenadiers, and covered the center of the position of the French army at the opening of the first campaign of Italy, 20th Germinal, in the year 4. TheAustrian General Beaulie, wishing to break the center of the French army, caused this redoubt to be attacked by 12,000 men, who were continually repulsed for a whole day and night. This brilliant defence gave the French general both the time and opportunity of turning the right flank of the Austrian army, and putting it into complete rout. (*Gay de Vernon.*)

Redoubts are employed, as has been already said, like lunettes, in the composition of lines with intervals, or to fortify a system of chosen positions.

OF FORTINS, OR FIELD FORTS.

Fortins, or Field Forts, are redoubts of a large size, in the construction of which it is endeavoured to procure flanking fires, by breaking the sides.

The difference between field forts and redoubts consists, 1. In the extent of their magistral line, which is more than 160 yards. 2. In their command over the plane of site, which is often greater than that of ordinary redoubts. 3. The change of the direct fires

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into efficacious flanking fires in the probable direction of the attacking columns, and for the defence of the ditch.

We have already seen that the two principal faults inherent in redoubts are, that the approaches are exposed only to direct fires, which are trifling and few in number on the capitals; and that the ditches are not flanked, and without any defence.

To these faults must be attributed the general opinion, that redoubts can easily be carried by assault.*

In order to obtain works that have not these two great faults of the redoubt, fortins are made, when the number of defenders is sufficient; for the interior surface increases in a greater proportion than the length of the magistral line, and the excess over what is required for the lodgment of the garrison permits the sides to be broken. For example, the redoubt with sides of 50 yards will contain 1,500 men, while its usual garrison is only 500.

The redoubt whose side is 150 yards, will contain 12,000 men, though its garrison need not be more than 1,500 men, or 2,700 at the very outside, according to the preceding calculations.

These great redoubts ought to be contrived with regard to the importance of the position they occupy, and to the actions which may take place in and about them; they should besides contain every thing which is necessary for the use of their garrisons.

"Among all the works yet known, that with bastions fulfils most completely the two essential conditions of a good defence. But as this construction cannot be executed upon a front of less than 200 yards, this work falls, on account of the extent of its interior, and the time requisite for its execution, within the limits of the fortification of places. (See, however, its construction at the end of this article, and fig. 25.) All other figures will only palliate in part the evils of the common redoubt, as we shall see more clearly by examining the figures of different forts.

Those forts which result from forming tenails on the sides of polygons, are called *Star forts*. By considering the different polygons, it will be perceived that the octagon, or star fort with eight

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* However, if flank and reverse fires be procured by means of caponniers, or casemates with loop holes in the counterscarp, good abbatis put in the ditch, and its approaches defended with wolf pits, crows feet, and *abbatis*, which retain the enemy under the fire, such redoubts will not be easily stormed.

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points, (fig. 24.) is that with the least number of sides which will fulfil the conditions of a good defence. For, 1. In the triangle fortified by half bastions, without the polygon, (fig. 21.) the salient angles, *a*, *b*, *c*, are less than 60 degrees. The smallness of this opening prevents manœuvres in their interior. The flanks *e*, *d*, are so small that they furnish but a feeble fire upon the long branches and the capitals. The faces are defended by fires so oblique that they may be considered as of no value. This construction ought, therefore, to be rejected. When local circumstances compel its admission, the only course to be taken is to round the angles of the triangle, or cut them off. *p*, *o*, *q*.

2d. It has been tried in the square whose side is 40 yards, (fig. 22.) to give its faces a better direction, by diminishing the interior capacity, which is double what is required for its garrison. The first method adopted is to break the sides *a b c*, *&c.*, so that the salient angles *b c d* shall not be less than 60 degrees, but in this case as the angle of the break *a b c* will be 150 degrees, the lines of fire cut one another opposite the re-entering angle only, and there are no cross fires upon the capitals. If to this fault be added the inconvenience of diminishing the size of the salient angles, and the capacity of the interior, it may be concluded that the square redoubt is to be preferred to that with tenails, except in the case where the position could be made to correspond with obstacles to which the salients of the works might be directed, so as to refuse them to the enemy. In it the tenailed square should be preferred, since it has cross fires upon the sides which would then be the vulnerable parts.

The second method is to make half bastions *a*, *e*, *f*, *i*, (fig. 23.) at the angles of the square *a b d c*. This construction is less faulty than in the triangle; it is, however, always weak; the faces *e f*, *o p*, *&c.* are without defence, and the capitals are crossed by fires of a very small extent from the little flanks *f i*, *p q*. In order to construct this figure, each side is divided into three equal parts *b q*, *q r*, *r d*, and prolonged a third of its length, *d s*. The point *r* being one of its divisions, *o r* is taken for the line of defence; through the point *q*, the flank *q p* is drawn perpendicular to the side *b d*.

It has been seen that tenailing the sides of a polygon, does not produce satisfactory results in the triangle on the square. In

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order to employ this method of procuring flanking dispositions, it is necessary that it fulfil three conditions.

1. The salient angles which project from it should not be less than 60 degrees.

2. The re-entering angle, or angle of defence, should not be greater than 100 degrees.

3. The side of the tenail ought to be so long, that it can furnish imposing columns of fire, and defend the ditch opposite the salient angles. This length, however, should not exceed a certain limit, so that the fire may cross upon the capitals with effect, and that the work may not be gigantic, and inconsistent with the garrison which should defend it. From 30 to 60 yards have been fixed as the limits of the sides that can be tenailled.

After the square comes the pentagon, which is not susceptible of being fortified by tenails, for the angles of defence would be 132 degrees.

In the hexagon the angles of defence are 120 degrees. The lines of fire converge toward the capitals. This contracts the front deprived of fire very much. The whole circuit should not be less than 180 yards. In order to obtain this figure, the sides may either be broken inwardly, or towards the exterior; constructing in each case equilateral triangles. In the first construction, the extent of the magistral or inner side of the parapet is 210 yards, so the ordinary garrison is 500 men; the work has a space within the banquet of 800 square yards. In the second case, the magistral is 360 yards, so that it is fitted for a force of 900 men at least; its interior space is 3,000 square yards.

In the heptagon, the angle of defence will be only 112 degrees; the fires will be directed towards the capital, but will not cross there favourably.

The octagonal figure, or the fort with 8 points, (fig. 24.) gives a construction which agrees with the principles laid down. It is the first of these forts that obviates all the inconveniences of the redoubt. The salient angle remaining fixed at 60 degrees, the angle of defence is not more than 105 degrees, which approaches very near to the prescribed angle of defence, or 100 degrees. The fires of the flanks cross each other upon the capitals, and by inclining them towards the salient, the edges of the counter-

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scarp, will be enfiladed, and the bottom of the ditch opposite the salients flanked. (*Gay de Vernon.*)

It must be observed that, in a star fort whose parapet is of the usual height, the fire of the faces will not reach the bottom of the ditch near the salient angle, unless the faces are at least 18 yards in length. It is for this reason that the side of the polygon of construction *a b*, (fig. 24. *bis.*) should not be less than 30 yards.

To construct a star fort with eight points, the sides of the octagon may be broken towards the interior, as *a d b*, (fig. 24. *bis.*) or towards the outside, as *g i f*, according to the space to be contained, and the force of the garrison. The simplest construction, however, of an eight pointed star fort, and that which is easiest in practice, is to form it upon a square, instead of tenailing the sides of a polygon. Let *a*, *e*, *m*, *p*, (fig. 24.) be the square whose magistral line and interior capacity are of the magnitude determined in the project of the work. Draw the axes *c q*, *l g*, on which four equilateral redans are traced, *r c s*, *t g v*, &c. whose sides are one third of the side of the square. Prolong the faces of these redans into the square to the points, *b d f*, so that the salient angles, *a e*, &c. shall be reduced to 60 degrees. The angles of defence *a b c*, &c. will be 105 degrees.

In this eight pointed fort, if the side of the square *a c*, be 60 yards, the interior surface is 2,700 square yards. The extent of the magistral is 346 yards; it, therefore, will not require a garrison of more than 900 men. It is the largest star fort which is usually constructed in the field.

In the octagon of 30 yards length of side, (fig. 24. *bis.*) which has been broken inwardly, the included space is 1,800 square yards; the length of the magistral 302 yards; (the faces are about 19 yards;) the ordinary garrison is 750 men.

Of the Bastioned Square.

In bastioned field forts, the extent of the front is not usually more than from 200 to 250 yards. Beyond this dimension, the flank fires would but weakly defend the salient angles. This extent, on the other hand, is never less than 125 yards, or the bastions would be too small, and the interior space and the flanks too contracted for the execution of manœuvres.

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To construct bastions upon the square *a b d c*, (fig. 25.) whose side or interior front *a b* is of the mean length, 200 yards; the perpendicular *p r*, must be made only an eighth part of the front, or 25 yards, (in order to produce salient angles of a proper size,) and the face *b h*, of the bastions, 60 yards. By following, in other respects, the construction we have already given, the line of defence *b f*, will be 141 yards; the curtain *f g*, 73 yards; the flank *g h*, 20 yards; the salient angle *h b i*, 62 degrees; the shoulder angle *b h g* 118 degrees; and the angle of the flank 104 degrees, within a few minutes.

The *Covered way* is the part of the natural ground *c c*, which touches the counterscarp; it is made from 8 to 10 yards wide; this is *covered* by the parapet *p p* of $6\frac{1}{2}$ feet in height, that forms the *glacis*, or slope *g g*.

At the re-entering angles of the counterscap, places of arms are formed in the covered way, such as *m n x*, in which are placed detachments intended to secure the communications. In order to defend the branches of the covered way from enfilading fires, earthen traverses *t t*, of from 9 to 12 feet thick, are established.

The parts of the covered way S S contained within the traverses nearest to the salient angles are called *salient places of arms*, and those in the re-entering angle, *m n x*, are called *re-entering places of arms*. Passages *o o* cut out of the glacis, and called the *defiles of the traverses*, afford free passage along the covered way. They are shut at the moment of attack by strong barriers, so that the covered way may be defended inch by inch, and not abandoned to the enemy until its parts have each made, in succession, the longest possible resistance. The passages *v*, which are 12 feet wide, are shut in the same manner.

It may be seen from this detail, that whenever intrenchments are preceded by covered ways, they are susceptible of a much longer defence, as the scarp of the work will be covered in the beginning of the attack by the glacis. Besides, the enemy may be assailed at the same time by fires from the parapet, and from the covered way, if their relief have been suitably combined. But in all cases, the covered way gives the advantages of two successive defences. If the work have an interior reduct, a final effort may be made. This reduct is often nothing more than a redoubt, with its faces so contrived that the greatest possible quantity of fire may

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be directed towards the points at which the enemy will probably enter the principal work. The thickness of the parapet of the reduct need not be great, because it can hardly be attacked by artillery. Three feet is sufficient. If it be made of wood, of large round trunks, its thickness will be still less.

In the above bastioned square, the circuit of the magistral line will be 937 yards. To line its parapet in two ranks, 1,874 men are required; there is, therefore, a great excess of space for the lodgment of its defenders, as it includes 21,100 square yards; but its garrison may be greater, because it must be regulated by the consequence of the position, and the actions which may take place in its vicinity. It must also be furnished with more or less artillery. A fort of this sort is destined to be occupied a long while, and must contain all the shelters necessary to cover its provisions and ammunition from the fire of bombs, and have space besides for the establishment of a reduct. (*Savart.*)

Of Works upon Irregular Ground.

When the works which are to be erected in the field, are upon irregular ground, modifications must be made in the profile and the tracé, in conformity to local circumstances. The fortification becomes then irregular, which arises from two causes, viz.

1. From the irregularity of the site on which it is itself constructed:

2. From the influence the ground, which may be occupied by the enemy, exercises over the dispositions for defence. Both of these will cause alterations in the construction of the plan, and of the profiles.

If, for instance, intrenchments cross a valley, they must not be constructed upon a straight line, but the front broken so as to re-enter from the height towards the bottom of the valley, bringing the salients upon the heights, and the re-entering parts into the hollows. The lower part is then retired from any commanding position, and the enemy cannot see to plunge his fire into it. It is often necessary to augment the relief of the different parts in the hollows, according to the nature of the ground, and its slope; thus, if the slope be three feet in 300, the ordinary relief should be augmented $2\frac{1}{2}$ or 3 feet, which will make the parapet 10 or 11 feet high.

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The slopes of heights have a great influence upon the value of the intrenchments which defend their approach. Works placed upon heights, whose slopes are accessible, but too steep to be defended by efficacious fires, may be reached almost without resistance; they have no other defence left than to dispute the scarp at the point of the bayonet.

Permanent Field Works.

Works whose use is not momentary, and which are constructed with greater care, and more leisure, are called by this name. Such are *tetes de pont*, *depots*, &c. of which we shall hereafter speak.

The resistance of Field Works is often augmented by defensive caponniers, reducts of timber, palisades, and other means, of which we shall treat in the following pages.

OF SECONDARY MEANS OF AUGMENTING THE RESISTANCE OF INTRENCHMENTS.

In order to correct the weakness of the greatest part of field intrenchments, that arises from their small relief and gentle slopes, that permit them to be easily mounted, and render their attack less dangerous, several secondary means are employed. These are, *Wells* or *Wolf-pits*, *Crows-feet*, *Abbatis*, *Palisades*, *Chevaux-de-frize*, *Barriers*, *Tambours*, *Caponniers*, *Interior Reducts*, *Small Mines*, or *Fougasses*, and *Water*.

Of Wells or Wolf-pits.

"A military well, wolf-pit, or *trou de loup*, is an excavation *t*, (fig. 36. *c*.) of the form of an inverted truncated cone. Its upper diameter is six feet, the lower three feet, and its depth is six feet. The earth that is dug out is placed upon the margin *L* of the pit, with a slope sufficient to prevent its falling back; into the bottom of each pit is driven a picket pointed at top, and at least three feet high. To place these pits advantageously, they are disposed in three or four parallel rows in the form of a quincunx. For this purpose equilateral triangles *t t t* are drawn, whose sides are

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21 feet each. The angles, and the middle of the sides of these, are the centers of pits. This sort of obstacle is very speedily prepared. (See fig. 36. *c.* which is a section, and fig. 36. *t.* which is a plan.)

"These pits are employed in many cases. 1st. In front of lines in order to render their access more difficult, and to stop for a longer time the march of attacking columns; 2d. Against the enemy's cavalry when it is desirable to protect a part of a line of battle from its attacks; 3d. In accessible plains that are to be defended by the use of a small quantity of water. In this last case, the earth dug out need not be heaped up round them, but must be scattered.

"Dispositions of Wolf-pits are often made in front of intrenchments, about 60 feet from the salient, and nearly parallel to the faces; they are also made upon the counterscarp and in the ditch." (*Gay de Vernon.*)

Of Crows-feet.

Crows-feet are four pointed pieces of iron so contrived that one point shall be always uppermost. The passages by which the enemy can reach intrenchments, are strewn with these, as well as those fords, where the waters are smooth. Crows-feet are every where useful against cavalry. Every means of studding the avenues by which the enemy may profit, with sharp points, will answer the same purpose; thus, harrows placed upon the ground, or planks filled with large nails, may be employed. Small pickets, which are sunk 18 inches into the ground, and project 10 inches, are also used. They are planted in quincunx order over the necessary extent, and at very small distances from each other. These different dispositions serve with equal effect to detain the assailant under the fire of the besieged.

Of Abbatis.

A line of abbatis (fig. 35. *aa.*) is an arrangement of large boughs of trees full of branches, or of trees of small size. They are prepared by stripping off the twigs and sharpening the point of those branches which are capable of making resistance. All the

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trees or boughs are then arranged along side of each other, the points towards the enemy. The branches are interlaced, and even fastened together with withes. In order that the system may be solid, and that the enemy may not derange it, the boughs are fastened down by forked pickets, well driven into the ground. The attack of such abbatis is difficult; cannon is requisite to ruin and cut openings through them.

Abbatis may be placed in several ways.

1st. In advance of the counterscarp, lodged in a cavity dug for them, and covered by a small glacis to shelter them from the fire of cannon. This disposition is good, and is most commonly adopted.

2d. They are also placed at the bottom of the ditch, in several rows buried up to the insertion of the branches. This method is preferred by some engineers.

They likewise serve to bar the avenues and passages of works, or the passes of mountains, to mask openings, and to render woods impenetrable.

In woody countries, where lines are to be erected to cover a frontier, they are usually composed of abbatis of great depth. It is only necessary to defend them by a few detached works, at suitable distances from each other, and in the rear of the abbatis.

The trees are sometimes only thrown down without being separated from their trunks; this is sufficient to close the passage of woods.

It often happens, that abbatis are made upon the eve of an engagement to cover weak parts of the field of battle, whether this weakness arise from the nature of the ground, or from the bad quality or small number of the troops.

Of Palisades.

Palisades are stakes of a prismatic form, (fig. 35. and fig. *f*.) Their section, whose periphery is about 1½ feet, is usually an equilateral triangle. They are inserted 3 feet into the earth. Two workmen can make 80 a day; and three workmen will place 60 at least.

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Palisades are either placed vertically, or very much inclined to the horizon, in which latter case they are usually called *fraises*; and an intrenchment is said, in the one case, to be palisaded, and in the other to be fraised.

To plant a palisade, a trench must be dug in the ground 3 feet deep, and $1\frac{1}{2}$ feet wide, in which the palisades are to be set about 3 inches apart. Several of them are then fixed in the alignment by means of a cord, and the others successively brought to it after they have been well settled at the bottom by throwing in earth. Nothing then remains but to fasten them at top.

This is done by nailing or spiking them to a horizontal lath at the usual breast height, (4 feet 6 inches,) to which each palisade is fastened. This lath is at least 6 inches wide and 2 thick, a spike with two points is sometimes placed upon the lath, at each interval of the palisade, to prevent an enemy from setting his feet upon it to leap into the work, which may happen when they line a covered way. In this case the horizontal piece is not more than 3 inches below the crest of the glacis.

"In order to place a fraise, its position, and the inclination to shelter it from the fire of cannon being determined, a course of small rests called the *coussinet*, is first placed horizontally in the body of the earth. Upon this the fraises are placed in a straight line; they are then fixed to the coussinet by nails or spikes. As soon as the work is completed, the earth is replaced above the coussinet. Fraises project usually 6 or 7 feet." (*Savart.*)

A row of palisades is placed either at the bottom of the ditch, in its middle, or at the foot of the counterscarp. Sometimes, but improperly, at the foot of the scarp. They are also planted in front of the counterscarp at the foot of the glacis; they are then defended by the direct fires of the intrenchment. Some engineers are opposed to this method of placing a palisade upon the covered way, because it prevents the troops from sallying out in order of battle. Without deciding this question, I believe that it is better not to use palisades, upon the curtains of the intrenchment of camps, and other works from which it is necessary to advance in order of battle; but there are also cases where the covered way must be palisaded.

There are several methods of placing fraises; upon the berm, perpendicular to the scarp or to the counterscarp, &c. Upon the

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berm or scarp they are more exposed to howitzes and other projectiles. When a fraise is placed on the berm, it is usually set horizontal at the natural level of the earth, or even dipping a little; it is thus charged with the whole weight of the parapet. Some engineers place it $4\frac{1}{2}$ feet below the edge of the counterscarp. (fig. 35.)

In all cases attention must be paid, that they do not rise above the level of the plunging fire of the parapet, and to hide them from cannon firing point blank, or from the view of the enemy.

Of Chevaux de Frise.

Chevaux de Frise are composed of a tree cut into 4 or 6 faces, and pierced with holes perpendicular to them in order to receive lances armed with iron points. (fig. 41, 42, 43.)

Chevaux de Frise are employed to shut passages and the gorges of works, to destroy fords, &c. As chevaux de frise are used to close all military posts, and as they may be executed by common workmen, it is proper for all officers to know their dimensions.

"The body of the tree *a a* (fig. 42.) is usually 9 feet in length and 7 to 9 inches in thickness. The length of the lances is 5 feet and their thickness $1\frac{3}{4}$ inches. They are placed at the distance of 8 inches. The body of the tree is sometimes cut into 6 faces, but it is sufficient to bristle it with lances in the form of a cross upon four faces. The lances may be morticed in, and fastened with strong nails and plates of iron, that connect them firmly with the beam or body of the tree. To render this machine moveable, (fig. 43.) the beam is pierced at one end with a hole of $3\frac{1}{2}$ inches diameter, perpendicular to one of its faces, into which is passed the extremity of one of the posts *p* made cylindrical at top. To support the other end of the beam, and give it a motion of revolution, four pieces of wood are placed two by two in the same vertical plane perpendicular to the axis of the beam, bolted strongly together, and each pair connected by a cross piece; the two cross pieces are 5 or 6 inches apart, and pierced by a bolt carrying a wheel *r*, that reaches to the ground, and moves upon a circular timber set into the earth. This extremity of the *cheval de frise* applies itself to

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the other upright post, and is fixed to it by a latch, or in any other convenient manner. (*Gay de Vernon.*)

When it is wished to connect together several chevaux de frise to form a defence with them, a ring *a* (fig. 42.) is made at each end of the beam; one of these carries a small chain of two links, terminated by a piece of iron in the form of a T, to be passed into the ring of the adjoining cheval de frise. In such cases the beam is never made longer than six feet, nor more than seven inches square.

Of Barriers.

The passages formed in field works are generally closed by chevaux de frise. Barriers (fig. 44.) are seldom used but in fortresses, and great posts destined to be long occupied. They require much labour in the construction.

These barriers (fig. 44.) are constructed between two large upright posts, *p p*, about 9 feet apart, which are 9 inches square and 7½ to 9 feet in extreme length. Their base is a large block, such as *b*, or their lower ends are connected by a piece of wood 10 inches square, named the lower sill, each end of which rests on a horizontal cushion *c*, the lower sill *d* is attached to the sill *s*, by fastenings *l*. The two leaves of the gate are made each of two uprights connected by two cross and one diagonal piece, the uprights are each 6 inches square and 6 feet long. Each pannel is filled up with laths. The leaves turn upon pivots, whose sockets are in the sill, and they are supported at top by a circular neck made on the upright, which works in a collar of iron fixed to the post. The barrier is kept shut by a large latch, or what is better, by a bar turning upon a bolt, one end of which is lodged under a staple, and the other in a lock.

Of Tambours.

Tambours are small redoubts of wood (fig. 32.) intended to close avenues, gates, and all openings which communicate with the outside. The form of a tambour is that of a small lunette, or redan, according to the place it occupies, and the reverse fires it is intended to afford. If, for example, the gate *p*, in the wall *m o*,

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is to be covered, it will be well defended by the tambour *a b c d e*, which has the figure of a lunette. The tambour will flank the work, and be at the same time flanked by it. If the wall make an elbow like *m o r*, the side might be made straight like that shown at *c i*.

The circumference of this work is formed by posts 9 or 10 feet long, and 3 inches square at least, when they are to resist musketry only, and not less than a foot when they are to resist heavy field artillery. They are placed vertically like palisades, and made to touch each other exactly. The height from the ground is from 7 to 8 feet, and two rows of loop holes are cut, one at the height of 4 feet 6 inches, the other on the level of the ground, as *d*. (fig. 34.) An inner ditch *t* 3½ feet deep is dug, which leaves a banquet *b* 2½ feet wide, to fire through the upper loop holes. In this ditch soldiers are placed who fire through the lower loop holes past the intervals of the upper rank. Or the upper row of loop holes is made 6½ feet high, (fig. 33.) and a banquet made of plank, the second row of loop holes is at the height of this banquet, or 2 feet to 2 feet 3 inches. A ditch *f* is usually made so deep that the enemy cannot reach the upper loop holes, or even the lower ones. The slopes of this ditch meet at the bottom, so that the enemy cannot remain covered in it.

Tambours are sometimes covered by a sort of roof, or penthouse, made of joists laid close together, or of several courses of planks, making a thickness of 5 inches, which will resist hand-grenades.

Where proper wood cannot be procured, a small crenelled wall is built two feet in thickness.

It may be seen, that by means of tambours, well disposed flanking fires may be obtained, and a straight line, naturally weak, rendered very strong.

Of Loop Holes.

Loop holes are openings made in walls, tambours, &c. to fire through. These openings ought to be largest within, both in heighth and breadth, in order to fire in different directions. The centers of the loop holes are 3 feet apart. The customary dimensions of loop holes are as follows, viz:

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In walls of about two feet thick.

	ft.	in.
Inner breadth, (this dimension varies with the thickness of the wall,) - - - -	1	6
Outer breadth, - - - - - -	0	4
Inner height, - - - - - -	2	0
Outer do. - - - - - -	1	6

In wood from five to eight inches thick.

	ft.	in.
Inner breadth, - - - - - -	0	7
Outer do. - - - - - -	0	2
Height, - - - - - - -	1	0

Of Caponniers.

It has been observed, that the chief fault of almost all field works is, that their ditches have neither fires nor any other species of defence. The assailant may, therefore, form in them, in order to make the assault in mass, and in good order. Files of palisades established across the ditches, and rows of trunks of trees, from behind which the defenders may fire upon the assailants when they wish to establish themselves in the ditches, have been contrived to defend those which are not flanked. The rows of palisades *c c*, or trunks of trees, (figs. 40. and 38.) are called defensive caponniers. Of these there are two kinds, the single and the double. Single caponniers consisting of one row of palisades, can only be employed when the work is disposed in such a way that the enemy cannot turn them, nor take them in reverse from the top of the counterscarp. If, for example, the work is a redan, (fig. 40.) whose gorge *a b*, is inaccessible, the ditches of the face may be defended by single caponniers *c c*, and in this case the whole circuit of the ditch is seen and defended by the fires of the caponniers. They also offer a commodious passage to enter into the ditch in force, to defend it at the point of the bayonet. But if the work be accessible on every side, simple caponniers are inadmissible, because they could be attacked in rear, and consequently rendered useless. If the work is a polygon, single caponniers will not be

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sufficient, even if the gorge be inaccessible, as there would be faces which are not seen, and therefore cannot be defended.

If the gorge *g i*, (fig. 20.) be inaccessible, simple caponniers placed at *g* and *i* will completely defend the ditches *g s*, *i r*, but the ditch *r s* will not be defended, and, therefore, caponniers are required in the line *f q*, to produce fires in the directions of *r* and *s*. In this case the double caponniers *c c c*, are employed, (fig. 38. shows their profile, and fig. 39. their plan,) formed by two rows of posts, set touching each other, and raised 6 or 7 feet above the ground, with loop holes on the two long sides, and in front. The distance between the rows is 6 or 7 feet. The inner space is covered like a sap, by laying beams across, covered by planks and fascines, and a layer of turf or earth 8 inches in thickness, to shelter the defenders. In order that the top of the caponnier may not serve the enemy to cross the ditch, the bottom of it is sunk, if need be, 2 or 3 feet below the bottom of the ditch, which also helps to shelter it from the fire of artillery. Neither must the caponnier extend to the counterscarp, but should be distant from it 4 or 5 feet. The communication to it from the interior of the work, is by a passage *g*, formed beneath the parapet, like the gallery of a mine. Palisades are made to join the caponnier to the scarp, and a small ditch is made before the caponniers, whose slopes meet at its bottom, as is shown in the plan. The surrounding ground must also be covered with pits, crows feet, and abbatis, so that the enemy may not reach the loop holes. It will be readily seen that caponniers augment the labour considerably, particularly by the foundation of the subterranean gallery, a work more delicate, and requiring more time in the execution, than the intrenchment itself. (*Gay de Vernon.*)

Instead of making them terminate in a square like *a b*, (fig. 39.) it is more advantageous to dispose them in a salient angle, *a m b*, which may be defended by the two half caponniers, *r r*, formed in the slope of the scarp. These, however, with the salient *a m b*, add considerably to the labour.

Of Reducts.

The utility of reducts has already been shown in treating of

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field forts. They furnish a retreat for the garrison in the interior of the work, from which the enemy may be fired at and prevented from establishing himself in the interior, and from taking possession of the cannon. These reducts afford the means of trying the chance of fighting, a second time, and give time to the troops within reach of the position to arrive; or at least of making an honourable capitulation, the hope of which sustains the courage of the soldier, and engages him to make a more obstinate defence.

It is not possible to erect a reduct in a little work which is only intended, to give notice of the approach of an enemy; by the noise of a short defence, but an important post ought to have one. A lunette may have a reduct at its gorge, which will defend it, and be a place of retreat for the garrison, it is the same with a redoubt, &c.

These safety reducts, which are also called *block houses*, are made like the double caponniers of which we have spoken. (fig. 38, 39.) Block-houses fitted to sustain the battering of heavy cannon may be built, by making the sides of two rows of wooden uprights, separated from each other by well-rammed earth about 4 feet in thickness. They thus become good casemates.

When an enclosed work can be attacked upon one side only, its reduct may be nothing more than traverses organized into a parapet, or a species of simple *caponnier*.

Tetes de pont, even those which are smallest have always a reduct, (often nothing more than a tambour,) to protect the retreat of the last troops.

In lines formed of two rows of works, lunettes for instance, those of the second line, enable the defenders of those in the first to contest them for a long while with the enemy, and protect the retreat when it becomes necessary.

Of Fougasses.

Small mines established under the glacis are called *Fougasses*. They are placed at the anticipated points of attack, generally in the neighbourhood of the salients, and from 6 to 10 feet outside of the counterscarp. Mines are only used in the defence of field works when they are very important, but it is a means that ought not to be neglected, although often of little real effect, for their

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explosion strikes terror into the assailants. By these, without other aid, the assault may be defeated, and troops who fear these subterranean fires, can rarely be persuaded to renew it. For the dimensions and charges of these small mines, see the article *Mines*, in the chapter upon Permanent Fortification.

To guard against surprise, it will be as well to light fires upon the points exposed to an attack, at the beginning of every dark night. By means of these the enemy may be seen at the distance of about three hundred paces.

Of the defence produced by Water.

Water is a powerful means of defence, and if attainable, ought never to be neglected. This species of obstacle costs but little, and often strengthens a post to the highest possible pitch.

"When a position is covered by water, 40 yards at least in breadth, and 6 feet deep, it is secure on this side from all attack by storm, unless there are fordable places which must be guarded by establishing intrenched posts opposite to them. The figure of these intrenchments must be directed by the nature of the bank, in such a way, that the fire of the intrenchments may cross upon the passages.

If there are any small islands, they must be occupied, and they will then both facilitate the passage, and keep the enemy at a distance.

Small water courses, passing near the intrenchments, must be made use of, either as advanced ditches, or by turning them into the main ditch.

"When a brook is found before a position, and its banks are steep, one or more dikes or dams, *d*, (fig. 45.) are established to raise the waters and fill up the basin. These ought to be constructed in such a way that the water may not run over them, as in that case they would be soon broken through, and finally destroyed. To prevent this, a sluice and a waste gate are constructed in the dikes by means of which the water may be kept at a given height, or raised and lowered at pleasure.

"Dikes in field works are made either of earth, fascines, or carpentry. The dike must be intimately connected with the two banks, on which account it should be commenced by cutting grooves into the banks to a proper depth. The earth should then

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be brought, thrown in, and beaten down, until it be sufficiently solid. It is often necessary to put a layer of well-beaten clay into the heart of the dike to prevent filtration. In works of the moment, and, in ordinary cases, the thickness at the top varies, according to the quality of the earth, from 8 to 10 feet.

"The slopes are such as the earth assumes by its own weight and texture; that which is opposed to the current is sometimes steeper than the other. When the current is rapid, and the stream subject to sudden floods, the two slopes are covered with planks, hurdles, or fascines. The bed of the canal is secured in like manner by courses of fascines picketed down for a sufficient length on each side of the dike.

When the dikes are high, fewer become necessary; the work is also lessened, and the defence becomes more complete; but this height has limits which are determined by the greater or less solidity that can be given. They cannot well be raised higher than 9 feet.

"When dikes are intended to serve as bridges, they are made 12 or 15 feet wide at the top. But this is generally a great fault, of which an enemy will not fail to profit. It is better to make them as narrrow as possible, and to construct bridges of wood that may be destroyed at pleasure, or burnt. To prevent an enemy from crossing, the top should be embarrassed by trunks of trees fastened together and difficult to be removed; in this point of view, dams of carpentry are preferable to earthen dikes.

"A sluice consists of two uprights set into a strong horizontal piece placed at the bottom. The gate moves in two grooves cut into the uprights, or the grooves are made large enough to receive the ends of square joists which are placed one over the other from the bottom to the top of the opening. The latter method of shutting up sluices is preferable in military constructions, because the levers of a gate may be seen from a distance, and cannonaded. It must also be observed, that the inundation may, in this way, be raised or lowered any given quantity that may be wished.

"The waste gate is nothing more than a part of the dike less elevated than the rest, over which the surplus waters may flow. If this precaution be not taken, a risk is run of having the dike pierced by the water. This waste gate has all its parts well covered with fascines picketed down, and this facing is continued

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a considerable distance along the bottom on the lower side *u t*, in order that it may the better resist the force of the water rushing over it.

"These dikes ought to be covered on the side towards the enemy by redans or lunettes *l l* (fig. 45.) flanked by works *o o* placed upon the opposite bank. When the nature of the ground will not permit the detached work to envelop the head of the dike, it must be placed as near as possible, and in such a way as to defend the approaches completely.

"When a basin of considerable length, for example a valley through which a rivulet or brook flows, is to be inundated, the number of dikes is regulated by the fall of the brook and the height of its banks, and the basin is divided by them into a succession of ponds. Thus the depth of water at the foot of the first dike being determined upon, the position of the second will be where the horizontal plane passing through the surface of water of that depth cuts the top of the bank of the stream, unless circumstances, arising from the pressure of the water, require the length of the pond to be diminished." (*Savart.*)

If the breadth of the inundated valley is so great that the works which cover the heads of the dikes cannot be defended by those on the opposite bank, epaulments may be erected in the inundation, in which musketry, and even small pieces of cannon, should be placed in such a way as to command the ditches and approaches of the advanced works.

APPLICATION OF THE ABOVE WORKS TO THE DEFENCE OF TETES DE PONT, PLACES OF DEPOT, TEMPORARY FORTRESSES, AND MILITARY POSTS.

Of Têtes de Pont.

The intrenchments which cover the approach to a bridge on the side possessed by the enemy, are styled *tetes de pont.* (pl. 2. fig. 26, 27, 28, 29, 30.) The strength of such intrenchments must be regulated by the importance of the passage they guard. When the bridge is established for a temporary purpose, to be defended by detachments, or small bodies of troops, the covering work is often only a redan, a lunette, or a priest's bonnet. A redan (fig.

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26.) is sufficient when the bend of the river is very great; the lunette (fig. 27.) is better on account of its flanks, when it becomes necessary to occupy their prolongation on a shore nearly straight. The capital may be 60 or 80 yards long, and the gorge from 100 to 120 yards. The flanks of the lunette may be 15, and the faces 50 yards.

Intervals *i i* are left between the extremities of the faces or flanks, and the bank of the stream, of 10 or 15 yards wide, which should be covered by an interior traverse *t*. These intervals are intended for the passage of troops and artillery.

Care must be taken that the ditch terminates in a glacis rising from the shoulder angles of the lunette, in order that they may be completely enfiladed from the other bank of the river.

Where the river is narrow, the tete de pont may be flanked by musketry only, as in the figures 26, 27.

Where the passage is more important, and more than one bridge, or a corps of an army is to be covered, a large redan (fig. 28.) is made, whose capital *o c* is about 200 yards, and the gorge *a d* 300. The returns *r* are made 40 yards, and the branches *b* 60 yards each. The passage is 20 or 30 yards wide. When the branches can be defended from the other bank by the fire of musketry, they may continue straight; but when the river is so wide that cannon must be used for that purpose, a cremaillere *r* is constructed in each flank, and it is lined with musketry.

Each bridge is covered by a reduct in the form of a redan, constructed of earth, or of large trunks, set touching each other, 6 or 7 feet in height. The reduct should have a command over the principal work, if possible, of from 2 to $2\frac{1}{2}$ feet.

" If the tete de pont must be still larger, a horn work (fig. 29.) is made instead of the large redan. This consists of two half bastions joined together by a curtain and terminated by two long branches, or wings, which make angles of 100 or 110 degrees at most, with the bank. The two bridges are about 100 yards apart, and the branches should be distant from them 60 or 80 yards, which will require the gorge to be about 260 yards. The front *r s*, or *a b*, is drawn parallel to the gorge, and must not be less than 100 yards; it may be increased to 250 yards, if the angles *i e*, that the branches make with the bank, are about 90 degrees. If this front do not exceed 100 to 150 yards, it may be fortified in

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the form of a priest's bonnet, as *r t s*; (fig. 29.;) but if it be more than 150 yards it is much better to draw a bastioned front *a m n b*, and even to add a redan or lunette. This latter work is indispensable, if the sally port be made in the curtain. Each wing has two crotchets, or cremailleres, the first without a ditch, and furnished with steps and a passage for the march of cavalry. Batteries should be disposed on the opposite bank in such a way as to flank the works."—*Gay de Vernon.*

A large bastioned redan, or a single crown work, is also employed, (fig. 30.) by which appellation is understood, a work composed of a whole central bastion, with a very acute angle, placed between two half bastions. The demigorges *a o*, *b o*, and the capital *c o* are all 160 yards in length, forming a triangle with 360 yards of base, and 180 of altitude. The bastioned fronts are traced upon the faces *a c*, *c b*, of the redan, *a c b*, making the perpendicular *p i* only one ninth part of the height of the faces. The intervals of 30 yards left between the bank and each half bastion, must be covered by the two redans *q q*. The two lunettes *r r*, may be erected within, united by an epaulment forming an obtuse angle, and furnished with steps on the inside, but without a ditch.

It is to be remarked, that a tete de pont, with a salient angle, like the great simple redan, (fig. 28.) and the bastioned redan, or single crown work, is preferable to that in the form of a horn-work, or priest's bonnet; because it is extremely well defended by the cross fires that proceed from the other bank. The other works, having a front nearly parallel to their gorge, do not possess the same quality.

When it is intended to secure the communications of a large army, or its retreat, if necessary, works of still greater extent are requisite. A double or triple crown work is then made, which is composed of two or three central bastions, between two half bastions, or else a system of detached works is used.

"There is nothing more rare," says General *Rogniat*, "than good tetes de pont. Their construction presents the difficult problem, of occupying and defending a large space with few troops; In fact, as they must, in preference to all other objects, secure the preservation of the bridge from the cannon of the enemy, it is necessary that the works shall extend over a semicircle of 13

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to 1500 yards radius. A less radius will not serve to keep his batteries at a sufficient distance. It is, besides, necessary that they protect the formation of the army, into order of battle, when it is about to march forward. For this purpose a large field of battle must be enclosed. On the other hand, it is not less necessary that this large circuit of works should oppose a formidable resistance to an enemy, and hold him in check with a small number of defenders, so that the greater part of the army may remain at liberty to carry on operations in other directions. The nature of the ground on the banks of rivers, which is almost always commanded by heights, is another difficulty attending the construction of a tete de pont. It has been found, that the best way, in most instances, of fulfiling all these conditions, is, to surround the head of the bridge by a reduct of two or three fronts, and to place around it, upon a circumference whose radius is 13 to 1500 yards, detached lunettes flanking each other at the distance of 4 to 600 yards, and protected at the gorge by the cannon of the reduct. Of these lunettes, 6 or 7 will be necessary, those on the extreme right and left placed resting immediately upon the bank of the river; a tete de pont is thus obtained, which will keep the batteries of the enemy at the distance of 17 to 1900 yards, and whose gorge is 2600 to 3000 yards. It will afford a field of battle of an extent of 32 to 3800 yards to prepare for a movement in advance. Each of these lunettes, with a magistral of 200 yards, must be fraised and palisaded, the gorge shut with a good palisade, and defended by a block house. The ditch must be defended by another block house, with reverse fires, constructed under the salient angle of the counterscarp.

" If these lunettes are well built, they ought to resist the best concerted open attacks with a garrison of 200 men each. Twelve hundred will then be needed for the six. The reduct, which surrounds the bridge, may be regarded as the soul of the defence, because it protects the gorges of the detached works, and preserves the bridge from surprise; from it, fresh troops, and other aid, proceed to reinforce or retake the lunetts that are attacked, and it offers a secure asylum to the remains of the garrisons of those which are forced. It must contain a reserve of 800 men. Hence, it may be seen, that 2000 men will be sufficient to put this immense tete de pont out of the reach of insult. If the enemy

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wish to force it, he must break ground; but, then, there will be time to relieve it with the rest of the army.

"If we choose a re-entering part of the river for the establishment of our tete de pont, instead of a straight part, we shall save labour; for we shall then have only the chord of an arc to fortify, and the works, placed upon a straight line, will acquire a new degree of force from that happy disposition."

OF PLACES OF DEPOT, AND TEMPORARY FORTRESSES.

In the course of an offensive war, it becomes necessary to establish places of depot, which are a species of intrenched camp, to secure a communication with the country in the rear, to protect the army of reserve, or the retreat, if necessary; to defend the stores, the hospitals, the work shops, &c. from the parties of the enemy, and the people of the country.

The circumstances of a defensive war will also require places of this description as substitutes for fortresses, which a state has not the means of raising upon every point of its territory where they may one day be wanted, or where the unforeseen events of a war may render them useful.

Permanent constructions in masonry do not apply to such temporary places, because there is no time for their erection. Their whole merit is in their momentary utility, and not in their durability. A mixed sort of fortification, which combines promptitude of execution with strength against the ordinary means of a campaign, is that which can alone fulfil the objects required by the pressure of circumstances. We shall extract what General Rogniat says on this subject. (p. 287.) The following is the sort of temporary fortress which he proposes.

"They must be spacious enough to receive an army of 30,000 men,* but so strengthened by art as to be defensible by few troops, against the means of attack an army usually carries with it in the field. The following construction modified according to local cir-

* It is evident that the same principles may be applied to the construction of places of a less capacity.

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cumstances, has appeared to me the most applicable to the purposes they are destined to answer.

"Let us take a hexagon with sides 600 yards in length, and construct two bastioned fronts, 300 yards in length, upon each of the sides on one straight line. Make the faces of the bastions 100 yards, and the flanks 36 yards, perpendicular to the lines of defence. The curtain will not be more than 50 yards, which is however sufficient, with the relief we allow, to let the fires of the flanks plunge to the bottom of the ditch opposite the middle of the curtain. The flanks will be about 200 yards from the salients of the bastions they are to defend, or at a good distance for the use of musketry fires.

"We place lunettes in advance, that we may have behind these detached works esplanades large enough for the encampment, and the manœuvres of troops. We put a lunette on each side of the polygon, (not upon each face of the work,) advanced 400 yards upon the capital of the obtuse angled bastion, which is in the middle of each side of the hexagon. It is now easy to see the reason of the above construction, for we have taken a large front, and divided it into two smaller ones in one straight line, in order that the advanced lunette, which cannot be nearer than 240 yards, may not be deprived of the flanking fire of the bastions. If its distance be less than 240 yards, there will be no room for establishing encampments.

These lunettes, to which we allow faces of 80 yards, and flanks of 40, protect each other at the distance of 800 yards; they are flanked by the fire of the acute angled bastions, at the distance of 500 yards, and have, upon the angles of the polygon, reverse fires sufficient to prevent the approach of an enemy. Their gorge, and the ditch of their flanks, alone, are near enough to be defended by small arms, from the body of the place. The ditch of the faces *m*, is too distant to be flanked in an efficacious manner; this objection is obviated by establishing a block-house under the salient angle of the counterscarp. Another block-house is placed in the gorge communicating with the ditch of the body of the place, by a subterranean gallery, so that it may serve as a safety redoubt for the garrison, and facilitate the recapture of the work. The rest

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of the gorge is shut by a *palanque*,* which is a palisade made of round trunks, of a foot in diameter.

"The lunettes are fraised and palisaded as well as the body of the place, or if circumstances permit, their ditches are filled with water, an obstacle more difficult to surmount than the best palisades. These intrenchments should have a command of 16 or 18 feet, in order to permit a covered way, to be established 10 or 12 feet lower than the inner crest of the parapet, and their ditches should be at least 12 feet deep. The branches of the covered way are formed into small cremailleres, or crotchets, from 2 to 4 yards long, so as to shelter their defenders from the effects of the ricochet, and furnish direct fires upon the capitals. The salient places of arms are spacious, and have, under their glacis, fougasses, which are well fitted to terrify an assailant. Subterranean fires, although producing little actual damage, strike the imagination of soldiers with terror; they are a cheap accessory to a defence, and should not be neglected.

The lunettes are united together by a covered way intended to cover the camp; the branches of this covered way are in lines drawn from the flank of one lunette to the salient of the adjoining one. This construction withdraws them from the enfilading ricochet fires directed along the faces of the lunettes. The crest of

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* A Palanque is a species of Fortification that makes a good defence, and will resist artillery, as was proved by the French at Dresden in the campaign of 1813. This city resisted, for a long time, the attack of 200,000 men of the combined armies; yet it was fortified by nothing more than a palanque, preceded by five little redoubts, at a great distance from each other. The original intention of the work was merely to preserve the town from the detachments of the enemy. The allies lost 10,000 men in the attack, and yet no practicable breach was discovered, next morning, in the palanque, after the most attentive examination. The balls had defaced the palisades, by passing through and between the posts, but had not broken them down. This example is sufficient to show that, in woody countries, a strong palanque may often be substituted with success for an earthen work. (*Rogniat*, p. 294.)

This instance of Dresden is well worthy of the attention of all officers in the American service. There is no part of our country, or its frontiers, where trees fit for the construction of a palanque may not be found in abundance. Even in the oldest settled districts, the rivers bring down to the sea ports large quantities of logs, of which formidable works might be erected. Tr.

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the glacis is elevated 6½ feet; and 12 feet behind the banquet, a platform or continuous banquet is formed 4 feet above the ground. This is intended to receive the field pieces of the army, which by its means, may fire over the crest of the covered way. This continuous platform will serve to unite the field artillery in battery, upon the points where the circumstances of the moment require, without interrupting the fire of musketry.*

"Instead of arming our covered ways with palisades, that only serve to impede the troops, by preventing them from sallying forth in order of battle, we shall make steps upon their inner slope, to facilitate the motion of infantry, and shall leave passages through the glacis for cavalry and artillery. In this way, the troops can march out with more ease, and less danger from the enemy, than through the gates of a continuous *enceinte*.

"Such is the form we propose for a permanent camp of 30,000 men. The esplanade which extends around the body of the place between the two covered ways is sufficiently spacious to encamp 24,000 men; the rest may be lodged within the place itself along with the staff, the parks, the magazines of ammunition and provisions, the hospitals, &c. To shelter these, huts or even bomb-proof coverts may be built. By this construction the assailant is compelled to force two enceintes instead of one.

"Three thousand men will be sufficient to guard this camp. Say 200 to each lunette, or 1200 in all, and 1800 for the inner fortification, including a reserve. This guard will not weaken the corps when it leaves the camp, because in it may be disposed the batallions of depôt, formed of the recruits, the sick, and the convalescents, in short, of all those who are unfit to fight in the open field, or to sustain the fatigue of marching. Such a force may be advantageously employed to defend intrenchments.

"It has been ascertained that a man digs, loads, or wheels upon a barrow, to the distance of 75 or 100 feet, 216 cubic feet in a day. If we calculate from this datum, we shall see that this permanent camp or temporary fortress, which we have described, may be

* Except immediately in front of the guns which are firing; but when the action comes to the point of the bayonet, the whole banquet may be lined with soldiers.

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finished by 15,000 workmen in a fortnight. A corps of 30,000 men may easily furnish such a number, upon fatigue, without interfering with the other duties."

OF PERMANENT INTRENCHED CAMPS.

Independent of temporary fortresses, a species of intrenched camps are established under the cannon of the chief fortified towns of a country. The camp forms, with the place, a single system, and draws great defence from it in some of its parts, while redoubts or isolated forts are thrown forward to cover others. When a permanent intrenched camp is constructed, either to receive an army which can no longer keep the field in consequence of defeats, or if it is to serve as a protection, or a pivot for an army in a defensive system, its capacity ought to be determined by the size of the army it may have to receive.

But when a permanent intrenched camp is only destined to occupy a height in the neighbourhood of a fortress, that might otherwise be valuable to the enemy, or to augment the strength of the position in some other way, its extent should be less.

In fine, permanent intrenched camps ought to be proportioned to the part which they may some day be called upon to perform.

OF MILITARY POSTS.

When an army occupies a country, either with a view of acting offensively, of maintaining itself upon the defensive, or of cantoning for the winter, it ought to occupy the villages, castles, farms, mills, &c., upon its front, flanks, and communications, and intrench them. They are then called military posts. The surprise of an army in its cantonments, or the success of a battle depends often upon the more or less obstinate defence of a village, farm, &c. Officers of every arm ought, therefore, to know how to fortify military posts properly.

When the villages, farms, &c., which are to be fortified, are near the body of the army that is to support them, they are intrenched upon the side next the enemy only; but when they are isolated and distant, as when they are intended to cover a com-

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munication, or to be occupied by advanced guards, or flanking parties; if they are parts of a system of cantonments, or if they can protect a retreat, or facilitate offensive returns, they ought to be intrenched upon their whole circumference, and have an interior reduct. The means of fortifying military posts consist, 1st. In the well-combined use of the different elements of field fortification, of which we have just treated, which are *Parapets*, *Ditches*, *Palisades*, *Abbatis*, *Chevaux de Frise*, *Barriers*, *Tambours*, *Dikes*, (if there be water,) *Wolf pits*, *Crows' feet*, *&c.* 2d. In *Enclosures*, *Meurtrieres*,* *Battlements*, *Barricades*, *&c.* Having already described the first of these, we shall now speak of the others.

If the enclosures are of wood or of earth, and more elevated than the usual breast height, (which is 4 feet 6 inches at most,) loop-holes are cut in them, or they are broken down to a convenient height.

A lower tier of loop-holes, with grazing fires, may be made, but an inner trench must then be dug, leaving a banquet 2 feet wide at the foot of the wall. This cannot be done if any risk be thereby run of undermining the wall. A second rank of soldiers is placed in this ditch to fire from the lower loop-holes through the intervals of the upper rank. (fig. 33. and 34.)

Interior Meurtrieres are made in the floors of the upper stories of a house to defend the doorways in those below, and to overwhelm an enemy who may have entered with stones, grenades, boiling water, &c.

"*Battlements*, (*Machicoulis*,) consist in a wooden gallery and parapet projecting about 3 feet from the upper part of a high wall; that of a church for example. The parapet is cut into loop-holes, and *meurtrieres* are made in the floor to throw missiles upon the enemy, when he presents himself at the foot of the walls.

Barricades are employed to shut up the streets, and all the communications, so that the enemy may be stopped, and prevented from passing through these openings. For this purpose

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* *Meurtrieres* are holes cut in the upper floors of buildings, through which stones, water, &c. are thrown upon an enemy beneath. Tr.

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logs are used which cross one another, forming a sort of casing filled with earth; also wagons buried up to the axles, and filled with earth, stones, or dung, agricultural implements, large articles of furniture, &c. Trenches are dug in front of them to keep the enemy longer under the fire.

Of dispositions for the defence of posts. (fig. 31.)

When a detachment arrives at a post which is to be intrenched, the streets and other avenues must first be shut by barricades, as described above, abbatis, &c. Epaulments must be quickly erected, if you have artillery, so as to dispose it against the approaches most favourable to the enemy. The houses, wells, hedges, and ditches of the environs that might afford shelter to an enemy, or injure the defence, must be destroyed. The doors and windows must be closed, and the loop-holes necessary to defend them cut, as well as loop-holes in the walls. After this, a part of the interior must be chosen for a defensive reduct; this may be either a church and its burying ground, or a large house. This part should be so situated, if possible, that a retreat from the post may be easily effected through it, by means of a river, a ravine, or other favourable local circumstance that will cover the retiring troops. After the place of this reduct is fixed upon, it must be entirely isolated; all the houses commanding it within musket shot should be demolished or burnt, as well as all those which mask it at too short a distance. Passages must be made, affording an easy communication from the reduct to the exterior defences, and tambours constructed before them. This reduct will be considered as the place of arms and of general rendezvous; as the point of retreat in which a new combat may be commenced, to allow time for assistance to arrive, or procure a favourable capitulation. A good reduct, well defended, often holds out longer than the principal work, and saves the post.

After the reduct is completed, the outside of the post is reconnoitred, in order to plan its defence, and determine the position of the several works in conformity with the nature of the ground on which they are to stand, or that in front of them. The purpose they are to answer must also be considered, whether it be to keep the enemy at a distance, or to furnish reverse fires upon the other

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parts of the intrenchment. Their profiles will be regulated by the nature of the attack they are to resist.

When all these preliminary operations are finished, the whole strength is applied to construct the works, beginning at the most important points, which are usually the salients, and finishing insensibly at those which are least so. The works may be either detached or continuous according to their position.

The example given (pl. 2. fig. 3.) will complete the elucidation of the principles of the defence of posts. Detached works mutually defending each other cover a part of the village, and the houses, hedges, or other enclosures, serve as curtains. On the opposite side the water course is completely defended, and two têtes *o* and *i* cover the communications. The height *m*, is strongly occupied by 3 lunettes. The communication is easy from every part to the reduct *r*, formed of the church and the adjoining erections. Tambours of trunks of trees defend the approaches, and a retreat may readily be made from it over the bridge *p*. There are other details which cannot be shown on so small a scale. (The batteries *b b*, and the columns of troops *c c*, are in relation to the attack of which we have treated in the first volume.)

It is important to place abbatis and crows feet, and make pits upon the approaches of the salients, that are the usual points of attack, because they are the weakest and least provided with fire. These will detain the enemy under the fire of the intrenchments, and in the midst of difficulties, and may alone defeat the attack. Chevaux de frise, and crows feet must also be provided, to place, at the moment of attack, in the breaches the enemy's cannon may have made. Grenades and howitzes are also useful to throw into the ditch when the enemy is compelled to remain in it until he cut the palisade, or destroy the obstacles that are in it. When the ditch is full of water, the enemy must remain upon the counterscarp during the time it takes to fill it up with fascines or hurdles; this adds much to the danger he incurs.

OF OPEN TOWNS.

What we have said on the subject of fortifying a field of battle by lunettes or redoubts, of the great tete de pont, of places of de-

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pot, of temporary fortresses, and of military posts, will apply to the works which may be erected around an open town, to put it beyond the reach of surprise, or even to defend it for a time against an army.

It will be seen, that nothing is wanted but a few detached bastions closed at the gorge, or redoubts well disposed, and of a good relief, supporting each other within the range of grape shot. These will prevent an enemy from passing and reaching the town without having first taken several of the works. They may, in fact, be no nearer than 1200 yards. In this case, they will only support each other by the fire of cannon balls; but the enemy, in passing between any two of these forts, will never be out of the reach of grape shot. These works may be flanked by the fires of long curtains erected subsequently, if time will permit, and of a less relief than they have.

These redoubts must not be out of the reach of the cannon of the town, even with the view of preserving it from the enemy's artillery. In that case, the ground between them and it would be too extensive and difficult to defend. Many more redoubts, too, would be needed, and they would be reduced to their own separate means of defence. They must be then made larger, and must contain within them, shelters for the garrison and its stores. Local circumstances ought, however, to govern their position and relations. (See PERMANENT FORTIFICATION in this volume. *The Defence of Coasts.*)

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ON PERMANENT FORTIFICATION.

OF THE UTILITY OF FORTRESSES.

It has been seen, that by the term FORTRESS, or STRONG PLACE, is understood, a town fortified with care and solidity, and in the most advantageous manner. It thus becomes capable of making the greatest possible resistance, with a garrison proportioned to its size.

As the construction of these towns, as well as of every other species of Fortification belongs to the corps of Engineers, I shall not enter into any minute detail with regard to them. I shall do no more than give an idea of the different systems of Fortification; of the parts which constitute a fortress, and the relations which ought to exist among them. Artillery being one of the chief agents employed to defend or reduce fortresses, it is necessary that its officers should be acquainted with the theory of Fortification.

I shall first treat of the utility of fortresses, and of the proper mode of placing them for the defence of a country. Military men have not yet agreed in opinion upon the last of these subjects. Some think that a frontier should be furnished with a triple range of fortresses, distant about a day's march from each other, crowded upon the extremities, while none are located in the interior. The consequence of such a system would be, that after an enemy had taken some of them, he might, by blockading the others, become wholly master of the country, whose armies would no longer have either a safe retreat, points of support, or magazines of arms, provisions, and ammunition. Others require, with more reason, that

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fortresses be placed upon the frontier, to occupy the principal positions only, while others are established behind them from distance to distance, to the very center of the state, in positions having relation to the movements of the armies that might be called upon to act in defence of the nation, in case of actual invasion.

In support of the latter opinion, I cannot do better than extract what General Rogniat, of the French Engineers, says in his Considerations on the Art of War.

"The necessity of Fortresses is acknowledged; They place out of the reach of harm, arsenals, ships in port, depôts of arms and stores, magazines of every sort, and, in a word, all those objects which should be provided at leisure, to prevent a nations being found unprepared, when war actually breaks out.

"Fortresses are necessary to occupy the great openings and principal passes of mountains, to place great marts of commerce in safety, to command important navigable waters, and to defend the more important points of a country. If seated upon the rivers of a frontier, they not only serve as a safe place of deposit for the magazines intended for the support of a war, but likewise as formidable *tetes de pont*, which continually menace the armies of an enemy, and hold him in check. They are avenues constantly open to act against, and attack him, while his attempts are frustrated by the river.

"Fortresses seated upon both banks of a river, perpendicular to a frontier line, are of a character still more advantageous than the former. They offer to an army acting on the defensive, the great advantages of passing from one bank to the other, so as to manœuvre according to the exigency of circumstances, and of keeping itself always covered by the river, from the enterprizes of the assailants.

Strong places serve, moreover, to collect the wreck of armies, after great defeats. The vanquished find within them all that is necessary to repair or replace their equipment, and to place their sick and wounded in safety. Troops dispersed by reverses run to them to seek refuge. They are there reassembled, rallied, and reorganized; they are armed anew, and again become bodies capable of appearing in the field. The unhappy remains of defeated armies which would have otherwise been the prey of the conqueror are

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formed again into effective corps under the protection of fortresses.

"Considered as the citadels of intrenched camps established under their guns, fortresses offer to armies acting on the defensive, points of support and of safety, which may have a decisive influence on the fate of their operations.

"Those military men who are worthy of conducting the great defensive operations of a war, have never contested the usefulness of fortresses for all these different purposes; but when it is proposed to close the frontiers of an empire against attack, by lines of fortresses alone, without the assistance of armies, opinions are divided as to the efficacy of such means. Are these pretended barriers capable of arresting the progress of invading armies? And were they doubled, or even tripled, would not the cost of their erection waste the treasures of the state without producing any certain result? In fine, may not the multiplied fortresses, which the present European system crowds along frontiers, be of more injury than use to active armies, as they weaken them by the detachments that are required for their garrisons.

"Let us suppose that the enemy advances to attack a frontier defended by a triple barrier of fortresses. His columns, without amusing themselves in sieges, penetrate between these fortresses; and in so doing, meet with no other difficulty than that of being compelled to follow narrow and inconvenient roads for a few miles.

"It may thus be seen that these defensive lines are unable to prevent an enemy from passing, unless, indeed, a chain of them were formed within cannon shot of each other, which is absurd.

"But it is said that when the columns of the enemy have passed, the garrisons may then play an important part, by sallying out, scouring the country, carrying off the detachments and convoys of the enemy, and interrupting his communication with his magazines. But he may, in spite of all this, escape these inconveniences, and preserve his lines of operation untouched, even in the middle of a labyrinth of fortresses, which are left to their own fate; he has only to cause his army of reserve to advance in order to observe those places which might be troublesome, by strong detachments.

"I do not wish it to be hastily concluded, from these observations on the insufficiency of lines of frontier fortresses for the defence of nations, that I consider strong places of little value. On

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the contrary, I allow them so great an influence on the stability of empires, that I think a good system of war cannot exist without fortresses. I only find fault with the present mode of placing them, and the crowding of them as chance may direct on the extreme frontier, where their great number becomes expensive from the quantity of troops required to guard them, while at the same time none are established in the interior. It is owing to such a system that a defensive army, which is forced by a series of disasters to abandon the line of the frontier, and is driven into the interior by a combination of distressing circumstances, finds itself separated from all its fortresses, and compelled to sustain the war without depôts, arsenals, magazines, or hospitals, without arms, ammunition, caissons, or points of support; it is in want of every thing in the heart of its own country; deprived of stores and the protection of garrisoned towns, it finds it impossible to reorganise.

"If by reflection and experience generals become convinced, that states cannot be defended except by means of armies; but that armies can neither be formed, nor organized, nor find safety or stability, without the aid of strong places; they will then have acquired a proper idea of defensive war. Its character will be well understood, the partizans of one opinion will renounce the foolish project of pretending to resist aggression by chains of fortresses alone, and those of the other will abandon the still more absurd idea of trusting the defence of a nation to an instrument so brittle as an army without depôts or points to rest upon, which may be dissipated without the power of reorganization, in the first battle that it loses. The part to be played by strong places in a war being well understood, it will be easy to see the points where the vicissitudes of a campaign may render them useful, and they will then be disposed more skillfully. Instead of accumulating them upon the frontier, they will be dispersed throughout the provinces that may possibly become the seat of war, to the very heart of the country.

"Upon an open frontier of a hundred leagues in extent, which the present system loads with fifty fortresses, I would establish in front no more than five or six, at the distance of 15 or 20 leagues from each other. They should occupy the points where great roads meet, and particularly both banks of every river, whatever may be its direction, thus facilitating the motion of armies.

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"About twenty leagues in the rear of this first range of fortreses I would establish another to serve as places of depôt, and protect the formation of armies of reserve. These should also be placed at the distance of 15 or 20 leagues from each other, and I would continue this arrangement to the very heart of the country, where there should be a general depôt of arms, provisions, and ammunition." (*Considerations sur l'art de la Guerre par le General Rogniat.*)

To establish a system for the defence of a country, and in order to know the principal places where the events of a war might render fortresses of value, we must first (as *Bousmard* has said in his *Essai general de Fortification*,) carefully study the nature of the country. We must then suppose two armies in action within it, one of which is an invading enemy endeavouring to penetrate into the heart of the country, to seize on the cities and other places he may wish to possess for the accomplishment of his designs. The other seeking and taking up positions proper to arrest his progress, and changing them in conformity with his movements. In the consideration of such a campaign between ideal armies, one of which is strong, and acting on the offensive, the other weak, and seeking to cover itself by every possible obstacle, it is impossible that in the end all the positions where strong places are necessary would not be discovered. Thus every position to which it is found necessary often to retire, or which should rarely be quitted if the country is to be preserved, ought to be occupied without doubt; if there be a valuable position which must be taken when the enemy makes a particular movement, but which cannot be safely reached and occupied in time, unless a certain passage be closed by a strong place; or would be unsafe if the passage of some neighbouring river were not secured, and the enemy compelled to make a long circuit to seek another. Such are the means of ascertaining the points where the defence of a country requires fortifications.

"It appears to me, that the most easy mode of planning a resistance against offensive combinations, is to divide the country to be fortified into a certain number of distinct parts as independent of each other as possible. For example, the ground between two chains of mountains, or between two great rivers, or between a mountain and a river, or which is surrounded by swamps, forests, &c., may be considered as a separate district. From a division of

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this sort, if it be well made, it will result that each portion of frontier taken separately will become a simple object, whose relation to the operations of the armies which are supposed to act within its limits will be easily comprehended. There will then be two things to do in each of these sections: The first will be to secure its most valuable position, the possession of which will maintain you in the district; either from its own capabilities, or as the centre of other positions certain to produce an effect upon the enemy's operations. The second will be to facilitate and insure the possibility of passing from this portion of the frontier to any of the neighbouring ones, in order to precede the enemy in the occupation of its chief position, or of those secondary but essential positions which depend upon it. The head of the passes between lakes, forests, marshes, and mountains, must be occupied, in order to make use of them in defence, or in marching to attack the enemy. (*Bousmard*, vol. 3.)

Defence of a Maritime Frontier.

The principal points of a maritime frontier should be fortified in proportion to the readiness with which succour can be afforded them. The places most favourable for the landing of an enemy, and the great commercial and naval establishments, should have fortifications of sufficient strength to resist the enemy, until the disposable force of the state have time to assemble.

An invading army can have no other object in view than one of the two following:

1. To seize on some good position near the coast, such as a bay, harbour, or the mouth of a river; in order to establish himself in it, make good his communications; and then march forward for the purpose of making conquests.

2. To possess himself of some great naval establishment, for the purpose of holding or destroying some commercial city of the first class, with the view of ruining it by carrying off its ships, plundering its warehouses, and compelling it to ransom from destruction every thing that he cannot remove.

It is not, then, necessary to make of the coast a fortified line, under the pretence that the more batteries there are, the less chance of the enemy's approach. No other plan, it is true, will prevent descents upon an extended coast, in consequence of the

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power of loco-motion, which exists in the squadrons that threaten it; but it becomes impossible to protect every point where they can make a landing; and besides, too large a quantity of artillery can neither be served nor furnished with ammunition; this would render such a mode of defence a bad one. All, then, that can be done, is to guard the most important positions; and to abandon, without resistance, those whose possession will not lead an enemy to any valuable result, or which place him upon ground unfavourable to the march of his troops; while some more efficacious means are provided for the defence of the country.

In the first of the two cases above mentioned, the prominent points along beaches where landings may be effected, and which are dangerous by their vicinity to important establishments, must be secured by forts or batteries. The same precaution must be taken with places fit for descents, and suspicious from the ease with which an enemy might march against those establishments; with roads possessing good anchorage, and safe from storms, in which a convoy might assemble; and with creeks which have, even at low tides, 12 or 15 feet of water, and space enough to contain ten or a dozen ships.

The batteries should be enclosed in the rear, because, as it is easy to turn them, they would, if open, be taken without difficulty. Instead, however, of making them little forts, which would require considerable numbers to defend them, it would, perhaps, be better to construct behind them small towers of masonry, with loop holes capable of sheltering and containing 10 or 12 soldiers to defend by musketry the cannon of the battery against the invading troops.

Other means are useful besides batteries, in the defence of a coast, and they must be as moveable as the enemy which attacks them. These means are guardships, and flotillas, (which are not within our present limits, as they appertain to the naval service;) troops and flying batteries placed within reach of the landing places most to be dreaded. There must also be places of depot, which contain arms and ammunition, and serve as rallying points, and places of refuge for the troops. These fortresses must be so calculated as to prevent the enemy making any progress into the country beyond them.

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In these moveable batteries, light pieces alone need be used, viz. six and three pounders and howitzers. This arises, from their value consisting in the power of advancing with rapidity against an enemy who should attempt a landing; in order to destroy his boats, cut up his troops, prevent their disembarkation, or defeat them by meeting them at the very first moment of landing. Small calibers are sufficient for these objects. If the enemy were to attempt a descent in your presence, field pieces of the largest caliber would not silence the artillery of his vessels that would sweep the shore. You must, therefore, wait until his troops are out of their protection, or you must cover your pieces, whatever may be their caliber, and fire from your covert against his boats and soldiers. In France, the defence of the coasts from Flushing to Nantz, has long been confided to 36,000 infantry, and 8,000 cavalry, with 132 pieces of cannon; on its whole Mediterranean coast, where there is less to be feared, there are no more than 54 pieces, 16,000 infantry, and 2,000 cavalry. (*Gassendi.*)

In the second case, when it becomes necessary to protect great naval or commercial establishments; their dockyards, arsenals, and warehouses ought to be enclosed with fortifications adequate to sustain a siege long enough to give succours time to arrive from the interior, and relieve the place.

"Such a place should also be out of reach of conflagration, by a bombardment either from the water or the land. The use of the harbour should, too, be retained, or forbidden to the enemy. This may be done by land batteries so situated as to prevent him from entering, or at any rate, from anchoring, if his entrance cannot be prevented. These batteries must be enclosed either in the works of the place, or in forts which cannot be taken but by siege and regular attacks. Bombardment by sea may thus be guarded against.

"To be in like manner free from the risk of bombardment by land, forts must be established in the environs of the place, safe from assault, and strong enough to require a regular seige." (*Bousmard*, vol. 3.)

Some military men erect these forts as far as 4000 yards from the place, to keep the enemy's batteries beyond the range of shells, others within 1200 yards, so that they may be supported by it. As the chief object is to preserve the place from

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bombardment, the batteries of the enemy must be kept beyond the distance at which mortars are efficacious, and as it is hardly to be imagined, that the enemy will have mortars with a range of 4000 yards, it will suffice to erect the forts 2400 yards from the place. This will prevent the enemy from establishing his batteries nearer than 2800 yards, the range of the common 12 inch mortar.

Great commercial cities may be protected by guarding the passes, and the mouths of the bays and rivers which lead to them, as well as the anchorages, that will permit the enemy to land within their reach, by forts. But if the anchorages be so spacious, or so numerous, as to render it impossible to close them all against the enemy, the cities must then be covered by detached forts that will keep the enemy out of the range of shells. The city itself may then be fortified against surprise or sudden attack, by a strong palanque, or a parapet, whose foot is defended by a ditch or some other obstacle, and the approach to it by the cross fire of a few batteries, while some forts or redoubts might occupy the most advantageous positions. (See *Field Fortification.*)

FIRST METHOD OF TRACING FORTRESSES.

Before the use of fire-arms, fortifications were nothing more than high and thick walls, which enclosed the cities and places. Square or round towers, jutting from the wall from distance to distance, gave the power of firing upon the flanks of those who approached them. The defenders were placed on the top of the walls, which they mounted by means of stairs, and they were then covered by a small wall or crenelled parapet, which projected from it. The support of the parapet, which was nothing more than a cornice of considerable magnitude, was pierced in such a way as to discover the bottom of the wall, and to permit the besieger to be fired upon when at its foot. These projecting parapets were called battlements, (*machicoulis.*) At this epoch towns were taken by storm by means of ladders, or their walls were breached by mines and the battering ram, that demolished a part of the foot of them in order to bring down the remainder.

The catapulta was used to throw large darts of the size of beams, and the balista to cast rocks of great weight. These ma-

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chines were placed upon high terraces, as near the rampart as possible, and towers to protect the battering rams were constructed, and directed under cover of their missiles.

When gun-powder was invented, it became necessary to change the form of the fortification of places, because the battlements, and even the walls, which were very high, could not resist the fire of artillery, nor could they, without a modification of their dispositions and dimensions, make use of this arm to defend them.

Masses of earth wide enough to plant artillery upon, were annexed to the inside of the wall, and thick parapets of the same material, substituted for those of masonry which could not resist the shock of the new projectiles, or were dangerous from the splinters that flew from them during the combat. To cover the masonry from the fire of the enemy, and to take advantage of the new weapons, the height of the walls was diminished, and the top of the parapet brought nearer to the level of the ground. To complete the system, the towers were replaced by bastions.

As bastions leave no point of the body of the place that is not seen and defended by some other, they were generally adopted from the very moment of their discovery, and successively improved and perfected. (Fig. 46. 47. 48. pl. 4.) To the bastioned system, were added different other works, advancing into the country, but diminishing in height, so as to afford several stages of fire, acting at the same instant of time.

In fine, by gradual additions to the systems of the engineers, (Errard, De Ville, Pagan, Cohorn, Vauban, Cormontaigne,) who are spoken of at the end of this chapter, the modern front, called after Cormontaigne, which is in use to the present day, was adopted. It is this which we shall describe in the following pages.

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DESCRIPTION OF THE SEVERAL PARTS OF A MODERN FORTRESS.*

The fortification of a place consists of a mass of earth or rampart, defended by bastions *a b c d e f g i*, &c. (pl. 4. fig. 49.) and surrounded by a large and deep ditch. It is covered in front of the curtain by a small work, *t*, called a tenail, and by another *l*, called a half moon. The whole is surrounded by a covered way *q*, so called because it is hidden from the country by a parapet. All the works between the rampart and the covered way are called generally the outworks.

The series of works raised round a city, or a piece of ground, is called *enceinte* or body of the place.

The enceinte of a place is composed of several points, such as *b g*, which are applied to the sides of the polygon that encloses the position. (It must be remembered, that a front is composed of two bastion faces, two flanks, and the curtain.) (See an explanation of the terms in "*Field Fortification.*")

The enceinte is often reinforced by works styled exterior, placed in front of the covered way, (fig. 55, 56, 57, 58,) and sometimes by detached works thrown forward into the country. These works will be described after having examined the modern front, of which we are about to treat.

MODERN FRONT. (fig. 49.)

The bastioned front, in this style of fortification, is traced in the same manner as in temporary fortification, but it differs from it in magnitude, and still more by the solid structure of all its parts.

Two hundred and sixty to 380 yards is given to the side *b g* of the exterior polygon on which the construction is made; the perpendicular raised at its bisection to determine the lines of defence *b e*, *d g* is made equal to one sixth or one seventh part of the side, the faces of the bastions are equal to one third of the side, and their flanks perpendicular to the lines of defence, which gives them a good direction for the defence of the ditch.

The length of the front or side of the polygon of construction is

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* This is compiled from *l'Essai General de Fortification par Mr. de Boumard.*

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such, that a fire of musketry, from the crest of the flank, may defend the next face along its whole length, reach across its ditch, and to the place of arms in the covered way of the salient angle; that the flanks may be long enough to furnish fire to counter-batter the breach batteries of the besieger which crown the covered way; that the bastions may be large enough to manœuvre with ease within them, and to afford room for retrenchments. A side of about 360 yards in length, such as we suppose, gives the most favourable dimensions to all these different parts.

If the point blank range of cannon, 600 yards, were taken for the length of the line of defence, it would make a much less certain resistance, and there would be greater danger of its being rendered altogether useless, as there is more risk of being in want of cannon than of musketry. Besides, there would be only one species of defence instead of two, and the curtain would become too long to be effectually covered.

The Rampart.

The *Terra Plain* of the rampart is usually 40 feet in width. A 24 pounder mounted upon a siege carriage, (which is the longest,) requires for its recoil about 24 feet, and the remaining space is necessary for the passage of ammunition waggons. The terraplain is the part of the rampart on which the besieged places himself and his artillery: the rampart is surmounted by another body of earth of less thickness, (20 feet at most,) called the parapet, which is intended to cover those upon its terraplain.

The height of the crest of the parapet of the body of the place, should be such, that a bullet fired from it may reach the third parallel, established by the besieger at the foot of the glacis, and may pass 4 feet above the crest of the covered way, so that the soldiers defending that work, may fire at the same time without being incommoded by the wind of the bullet.

"Of the various methods of facing the exterior side of the rampart, which is called the *Scarp*, that in masonry is to be preferred, particularly when it is at least 25 feet in height. At this height it requires ladders of such a weight, to scale it, as cannot easily be managed. An earthen scarp, with a wet ditch, has the fault of exposing the place to be taken by surprise in time of severe frosts. An earthen scarp, upon a dry ditch, is the worst of all, as it may at any time be scaled by cutting its palisades with a hatchet. In be-

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sieging it, it does not become necessary to establish batteries in breach, a passage of the ditch alone will be sufficient, as the natural slope of the earth of the rampart will permit it to be mounted.

"An earthen counterscarp spares the besieger the long and dangerous labour of the descent of the ditch, and facilitates the capture of the whole covered way when once a part of it is taken." (*Bousmard.*)

Bastions.

Bastions for a long while were made with orillons, but these have not been employed since the introduction of large half-moons, that cover the shoulders of the bastions, and the flanks in consequence in a sufficient manner. The orillon consisted in the prolongation *e*, *m*, *o*, *p*, (fig. 46, 47.) of the face, and its principal object was to cover the artillery placed on the re-entering part of the flank. The orillon prevented the besieger from counter-battering this artillery, so that it served to fire upon the breach at the moment of assault, but, on the other hand, they reduced the value of the flank in other respects, to little or nothing, although the most important part of the fortification; for it is by its fire alone that the establishment of the enemy at the salient angle, opposite the bastion, can be opposed; the battery he may have established there overthrown; or effectual opposition made to the passage of the ditch.

The earlier engineers constructed the flanks with casemates, to multiply their fire; they, afterwards, abandoned this method, probably to avoid the inconvenience of a suffocating smoke. In order to preserve the same quantity of fire for the defence of the ditch, and even to increase it, low flanks, *o p*, (fig. 48.) were made two or three stories high, protected by the orillon against an enfilading fire; but since the increased use of bombs, the artillery in them is quickly dismounted, and being surrounded by revetments of masonry, they are very dangerous to occupy.

The Ditch.

Ditches full of water cannot be too wide; and when dry, they can neither be too narrow nor too deep. In the first case, the width increases the labour of crossing them; in the second, their being made narrow augments the difficulty of opening the breach low enough for it to be accessible. They have generally a width

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of 30 or 40 yards before the body of the place, and from 20 to 25 in front of the half moon.

Postern.

The Rampart is pierced at its foot, near the centre of the curtain, by a passage *p* leading from the interior of the place into the ditch, this passage is termed the *Postern.*

Tenail.

The postern is covered or protected by the work *t*, called a tenail, which has also a space behind it in which the sorties that are made into the ditch, in order to harass the troops who attempt its passage assemble. But its principal object is, to prevent a breach being made in the flanks, or the curtain. This ensures the preservation of their parapet, until the end of the siege, and, consequently, the use of musketry, and such artillery as may remain at that period. This work also serves to defend the half moon, the ditches and the covered way, by a closer and more raking fire, less exposed to the enemy than that of the body of the place. This last was the sole object accomplished by the *fausse braié* of the ancient engineers, and it had, when compared with the tenail, the disadvantage of serving as a scaling ladder, and as a ramp to the breach of the body of the place. It had, besides, the inconvenience of receiving all the splinters of the scarp, which it bordered. This *fausse braié* is a second inclosure, lower than, and immediately in front of, the first. (*Bousmard.*)

Caponnier.

The tenaille is pierced through its middle by a postern, so that by means of the work *c*, *a*, there is a safe communication with the half-moon, and other outposts; this work, which is termed caponnier, is merely a passage between two small parapets shaped like a glacis. (See its profile, fig. 51.) This double parapet is used in case of need, to defend the bottom of the ditch.

The Half-moon.

"This work *l*, termed *Half-moon*, was first known under the

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name of *Ravelin*, and afterwards under that of *Half-moon*.* Its first object was to cover the bridge that leads to the country, but it was soon found that by making it large, other advantages could be drawn from it, and that it would be useful to place such works before all the fronts of a fortress, whether there were entrances to be defended or not.

"The use of the half-moon is to cover the curtain and the flanks from the reach of the cannon of the besiegers, until they succeed in lodging themselves on the crest of the covered way; and, consequently, to preserve to these parts of the fortification, all their power of defence, for that era of extreme emergency. This is the reason why they are made with only two branches, and that the flanks are suppressed that exposed the shoulders of the bastions, and made their flanks liable to distant ricochet fires; and also to be enfiladed and rendered untenable by a nearer fire, when the besiegers had succeeded in levelling the parapet of the faces near their junction with that of the flanks. It is also for this reason that the prolongation of the branches of the half-moon, is made to strike the bastion at 30 yards from the angle of the shoulders, instead of 10 yards, as was the custom formerly. Besides, the fire of the half-moon is brought nearer to the covered way, in front of the face of the bastions, than that of the flanks; and it is on the crest of this that the batteries in breach are placed. It is then necessary to make large *half-moons*, and give them as much projection beyond the bastion as possible. When this is done, the ditch, and the covered way by which it is surrounded, make with those of the bastions two re-entering angles, nearer to the salients, (which are the weak parts,) than the place of arms would be when placed at the re-entering angle of the counterscarp of the front, unsupported by the half-moon." (*Bousmard.*)

[In order to obtain the largest possible half-moon, an equilateral triangle is constructed on the line that joins points taken on the face of the bastions, at the distance of 30 yards from the angles of the shoulder.]

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* It was styled half-moon by the military authors of England as long ago as the time of Charles I. Tr.

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Reduct of the Half-moon.

Half-moons of large dimensions will admit of making an intrenchment within them *r*, faced with masonry, and with a ditch, to enable them to make an obstinate resistance. This retrenchment is called the reduct. It may indeed be said, that this reduct is itself the half-moon, and that the faces, of what is called the half-moon, are merely counter guards to cover it. By means of this reduct, the besiegers are not only obliged to batter the faces of the half-moon in breach, but to destroy them in a great measure, that they may be able afterwards to batter the reduct. The terraplain of the face of the half-moon having no more breadth than is necessary for a cannon; the besiegers cannot establish batteries upon it without being obliged to remove all the earth that forms its parapet, to construct the parapet of their own batteries, and leave a sufficient width behind to place their guns upon. Besides, the rear of those pieces will be partially seen from the faces of the bastions of the place. The taking of the reduct will require a breach, and a passage of the ditch according to rule, for its ditch is enfiladed by the faces of the bastions. Its figure is obtained by drawing lines parallel to the faces of the half-moon, from the shoulder of the bastions.

Reducts usually have flanks, which can contain three guns that have a reverse fire upon the passage of the ditch and the breach of the bastion. This will compel the enemy to take possession of them before he makes the assault.

The flanks of the reduct are pierced with two posterns *o*, that lead into its ditch; from this ditch the faces of the half-moon are entered by stairways *e'*, called *pas de souris*. The ditch of the half-moon communicates with that of the body of the place.

The Covered Way.

The covered way *q*, is a space of ground contained between the ditch and a parapet towards the country, *x*, called the glacis. The covered way affords the advantage of collecting troops to act against the enemy. It enables the besieged to move in safety along the whole of the counterscarp, and to pass to and from it. It furnishes a closer and more raking fire than that of the rampart.

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It protects by its elevation the revetments of the works, which the besiegers can only batter in breach, by establishing their batteries upon the crest of the glacis, where they are exposed to a plunging and close fire from the works.

In order to defend the covered way obstinately, and not be compelled to abandon its branches as soon as the enemy shall occupy its salient angles, traverses *t* are placed at the distance of 30 yards from each other. Finally, to be able to bring together in safety numerous bodies capable of making sorties with effect, spacious places of arms *p*, are made in the re-entering angles, and as the defence of covered ways consists, principally, in these re-entering places of arms, good reducts *r'* are made within them with a ditch and revetments. These reducts, besides, cover the openings of the ditch, between the extremities of the tenail and the flanks of the bastions, and prevent the besiegers from establishing batteries upon the crest of the places of arms, that might annoy the flanks of the bastions, and a part of the curtain. A small flank is made to the reduct on the side next the half-moon, to cover part of the interior, as well as the stairway that leads to it from the ditch, and to take the besiegers in rear when they attack the breach of the half-moon. (*Bousmard.*)

There are also salient places of arms, *s*, opposite the salient angles; they are not so large as, and are of much less advantage in the defence, than re-entering places of arms.

Ten yards in width is generally allowed to the covered way; if it were narrower, the movements of the troops that defend it would be impeded; if wider, it would admit the establishment of batteries in breach within it. This would be an advantage to the besiegers, who would be sheltered from the reverse and enfilading fires of the besieged, by means of the relief of the glacis and the traverses. Between the traverses and the glacis, a passage is left which is termed *the Defile of the Traverse.*

The glacis should be made sloping towards the country, so that every part of its slope may be seen by the soldiers placed upon the banquet of the body of the place; this would not be the case if it were too steep.

Sixty yards in breadth, and 1½ inch slope per yard, are usually allowed it. It must not be made steeper, but it may be less so if it be rendered necessary by the construction of the works erected

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in the rear. The crest of the glacis of the covered way, should be at least 6½ feet above the level of the country, so that the trenches of the besiegers may not overlook it, and that its fire may have some superiority over them. This is the minimum of command for the crest of the covered way of the half-moon, but 18 inches more is allowed to that of the bastions, in order that this covered way may command that of the half-moon, which is liable to be first attacked.

Counter Guards.

A work *c c*, termed Counter Guard, (fig. 53.) is sometimes used; it serves to cover the faces of some other work, and more commonly a bastion than any other, although they are also used to cover half-moons when small. In this last case, the counter guards may be mistaken for real *half-moons*, or rather the faces of a large *half-moon*, as in the fig. 49. may be termed counter guard, which has in its interior a reduct faced with masonry and terraced, which is then called the "half-moon." In fact, the half-moons, with reducts, which we have heretofore spoken of, are from their properties, and their object, real counter guards.

A counter guard is, therefore, a work destined merely to cover another of more importance, so that, without interrupting its action, it protects it from being battered in breach, until it be itself taken. It is necessary that the counter guard should be so narrow as to prevent the enemy from finding a sufficient space in it to place his guns; and that he may not have a choice of means to employ in battering the principal work in breach. (*Bousmard*, p. 23, vol. 2.)

Small half-moons may be covered by counter guards, to give them the advantages of large half-moons with reducts. Sometimes to increase the strength of a fortress already built, it becomes necessary to put counter guards before the bastions, when they have too much elevation, and their revetment is seen from the country. These will then prevent the bastions from being battered in breach, and the place from being carried by assault as soon as the breach is made.

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Tenaillons.

Works, such as *a*, *b*, (fig. 54.) with which small half-moons, and the shoulders of the bastions, were formerly covered, are called *Tenaillons*. The inspection of the figure suffices to show, that these works are bad, for they leave in front of the capital of the half-moon, a space that cannot be seen from the body of the place. These works are but little valued, and counter guards are preferred to them.

Cavaliers and Retrenchments of the Bastions.

When there are, in the vicinity of a fortress, hollows into which it is essential to fire, least the besieger should profit by them in the conduct of his attacks, or when some parts of the work are to be defiled from the neighbouring heights; large masses of earth are raised in the bastions, on which artillery is placed, to look into the hollows, and batter the heights; these are called *Cavaliers*. The great command of the *cavaliers* allows their fire to be employed against the enemy from the very commencement of the seige, and during the greater part of the continuation of the attack. Vaults may also be established under the terraplain, which will be useful.

In order that these Cavaliers may serve as retrenchments to the bastions, they are made in the shape of a small bastion, *k*, (fig. 49.) the faces of which are separated from the terraplain of the bastion by a narrow ditch *f*. Works *u u*, perpendicular to the faces of the bastion, are made with a ditch in their front. In this manner the *cavaliers*, the flanks of the bastion, and the curtain, form an inclosure, behind which the besieged may still defend themselves after the assault, or capitulate, if reduced to that emergency. This also compels the enemy to make a lodgment upon the top of the breach, which is a difficult and dangerous operation.

When there are no cavaliers in the bastions of the front of attack, nor any other established retrenchments; they are retrenched during the siege by raising works in the interior. The command of these differs but little from that of the main body of the place. These works may consist of a redan or of a tenaille,

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(bastions 1 and 2. pl. 8.) This fortification must be so contrived as to cover the flanks of the bastions, so that the batteries that defend the great ditch need not be abandoned as soon as the assault takes place. Sometimes, when there is neither time, men, nor materials, nothing more is done than to retrench the two bastions of the front of attack by prolonging the parapet of the curtain through them.

Of Command in Fortification.

It has been mentioned, under the head of Field Fortification, that the command of a work is the height of the top of its parapet above the ground or plane of site. And the command of one work over another, the difference of height between their parapet. Relief is the height from the top of the parapet to the bottom of the ditch.

The works are to have a command over each other as they approach the body of the place, in order that their fire may sweep over those in front, when the enemy has become master of them, and that they may, before that event, act jointly upon the attacks; this is, however, only true as regards the command of the principal works: viz. of the main body of the place, and of the half-moon upon their covered ways. The secondary works, which are the tenail and the reducts of the principal ones, have but little command over them, and their fires cannot be simultaneous.

It has just been said, that the fires of the half-moon, and its covered way, should be simultaneous; therefore, as the fire of the half-moon ought to reach the foot p of the glacis, where the besiegers establish their third parallel, (fig. 52.) and pass over the crest of the glacis as much as 4 feet, so as not to interefere with the musketry of its banquet; and as the cannon are fired from embrasures whose sills are $3\frac{1}{2}$ feet below the crest of the works, it follows, of course, that the crest of the half-moon should be about 8 feet above that of its covered way. This depends also upon the distance between the parapet, whence the fire proceeds, and the covered way. The same thing is to be observed with regard to the body of the place, but it should have besides a command over the works in front of it.

In a regular fortification, about 19 feet of command from

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the crest of the *enciente* over the plane of site is usually allowed, and 8 or 9 feet for the command of the covered way. The body of the place has then 2 feet command over the reduct of the half-moon; the latter 3 feet over the half-moon, and this about 8 feet over its covered way, which has $6\frac{1}{2}$ over the country. The command of the cavalier is regulated by the position of the points that it is to see and batter; if it is not to depend upon this, it is sufficient to make it 3 feet. As to the tenail, the inner crest of its parapet should be placed at least 2 feet below the line of fire drawn from the embrasure of the flank to the foot of the breach. The foot of the breach is 6 feet above the bottom of the ditch, at the place nearest to the shoulder where this breach can be made. The parapet of the reduct of the place of arms should be commanded 4 feet by the body of the place, and should have a command of at least 2 feet over the glacis of the bastions.

Figure 52 is the profile upon the lines *m n*, *n v*, *v h*; fig. 50. is the profile upon the line *k y*; and 51. that of the profile *z z*.

It is in the combination of the different works, that have just been mentioned, and in their relation to each other, that a fortified place consists; they are, however, not always so simple. There are often exterior works, (those which are beyond the covered way are thus called,) established to remove or obviate a defect in the figure of the body of the place, or to occupy ground, the possession of which may be of some advantage; or sometimes to add strength to the whole. Fortifications of the latter class are advanced covered ways, advanced ditches, and lunettes. In the two first cases, horn works and crown works; such are also lunettes, redoubts, forts, &c. far in advance of a place; detached works often inaccessible, (in a swamp, a pond, upon a rock, &c.) These render the attack of the front impracticable, or at least very difficult, by producing enfilading and reverse fires upon the ground of the attacks. We shall now proceed to give an idea of all these works.

Of the advanced Ditch and advanced Covered Way.

The advanced ditch *f f*, (fig. 56.) is a ditch dug at the foot of the glacis of the covered way of the Fortress. It is sometimes established in order to procure earth for the construction of the works of the fortress, when rocks, or other circumstances, do not

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allow giving the necessary depth to the ditch. When it can be filled with water at pleasure, it increases the defence. When it is possible that the enemy may drain it, without making himself master of it, or when it is made for the purpose of procuring earth, the side towards the fortress must be made of the same slope as the inner glacis, so that the enemy may not be sheltered from the fire of the garrison, when he has taken possession of it.

THE ADVANCED COVERED WAY, is a second covered way, *q q*, (fig. 56.) established in front of the advanced ditch to protect it; or in front of the glacis of the fortress, when there is no advanced ditch as is indicated in the part *b*. This work is only fit for fortresses that are strongly garrisoned, as it requires many troops for its defence, and the object it is intended to fulfil.

This advanced covered way is nearly parallel to the crest of the other, and should not be distant from it more than 100 yards, in order that the salient angles of the lunettes may be defended by the musketry of the covered way of the place. It is supported by fleches or lunettes *r* and *h*, placed upon the capitals of the bastions, and of the half-moons; they have faces from 30 to 40 yards in length, and 5 or 6 feet of command over the crest of the advanced covered way; a palisade is placed at their gorge. Their communication with the covered way of the fortress is secured by a caponnier, or else by a subterranean gallery, as in *b*. The latter is a cover from bombardment, and does not intersect the ground that separates the two covered ways, a free passage over which is so necessary for sorties. The artillery, thus placed in the most advanced points, will act with every advantage to keep off and retard the approaches of the besiegers. It will be seen in the *Defence of Fortresses*, that fleches or arrows, such as these, *r* (fig. 58.) are used at the bottom of the glacis, though there be neither advanced ditch nor advanced covered way. (*Bousmard.*)

OF HORN AND CROWN WORKS.

A work *a* (fig. 55.) composed of a front, or of two half bastions, joined together by a curtain, and terminated by two long sides *d d*, called branches or wings, is termed a HORN WORK.

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A Crown Work is a large work composed of a bastion and two half bastions terminated by long branches *e*, *e*. When there are two bastions and two half bastions, as fig. 57. it is a double crown; and when there are three bastions, it is a triple crown.

These works were originally used to occupy points, favourable to the besiegers, in front of a fortress, such as the borders of a valley or a height; to form a tête de pont; to enlarge a fortress so as to allow it a greater space, without which it would not serve to receive the stores that have accumulated to too great a degree in an army; to strengthen a weak front; to remove or correct a defect. The whole fortification of places was afterwards crowded with them, so as, in some measure, to double their means of defence, but to accomplish this last object, lunettes placed in advance of the fortification, are now preferred, like those *l* and *p*, (fig. 58.) The taking of one of these detached works does not necessarily follow that of the other. The besiegers are, therefore, compelled to attack them separately. Great sorties are much more easily made upon the free space between these lunettes, than through the covered way of large continuous works. Finally, these works are less difficult and less expensive to construct.

These horn, or crown works, should be carried beyond the covered way, (as in fig 57.) because, when their ditch opens into that of the place, (as in fig. 55.) the taking of the work facilitates that of the place; instead of which, the enemy is compelled, in the other case, to make his approaches over open ground, in order to establish breach batteries on the crown of the covered way, and must again execute a passage of the ditch, operations that are tedious and dangerous.

OF DETACHED WORKS.

An isolated work, in advance, entirely separated from those of the place, and connected with it neither by its ditch, nor by its covered way, is called a Detached Work; as for instance, the lunettes, *l* and *p*. (fig. 58.)

"These works are employed to augment the strength of a front by opposing increased obstacles to the enemy, removing him from the enciente of the place, and compelling him to open his trenches at a great distance. They render the attack of the adjoining fronts

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difficult, by furnishing enfilading and reverse fires upon the saps. They may occupy essential points near the place which it would be dangerous to leave at the disposal of the enemy; or may cover the suburbs of a city, &c. (*Bousmard.*)

In the first case, the lunettes, *l*, *p*, (fig. 58.) are employed, which are placed at about 250 yards in front of the capitals of the bastions; to make a complete system of lunettes, a second row is placed in front of the capitals of the half moons. These lunettes should have a good relief, be well closed in the rear, and have reducts in the places of arms. The best communication with the body of the place is by means of subterranean galleries; uncovered communications, through double caponniers, are unsafe: besides, they cut up the ground, and, therefore, impede the manœuvres of sorties.

In the second case above mentioned, when the object is to procure enfilading and reverse fires, upon the approaches of the enemy against the works; works are raised in an inaccessible spot, if such can be found in the neighbourhood of the place, (in an inundation, for instance,) to give reverse fires on the fronts, near this inundation, upon which the besiegers would probably place the right or left of their attack.

Detached works are either lunettes, reducts, bastioned forts, crown, or horn works, according to the importance of the place they are to occupy; the greater or less facility of affording them aid; and the means the enemy might employ to attack them.

When the detached works are not in an inaccessible spot, and they cannot be defended at their gorge by the musketry of the place, they must be as strong as possible; either by making a ditch at the gorge, with subterranean galleries, pierced with loop-holes at the scarp and counterscarp; or by means of a small tower constructed in the centre of the gorge, with two rows of casemates. The fire of the lower of these protects the gorge, and the upper plunges into the interior of the work. Casemates having reverse fires, are also established under the salient angles of the counterscarp, as is indicated at the lunette *p*, (fig. 58.) which has a casemate with reverse fires, and a safety redoubt. A system of mines may also be established for their defence.

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OF CITADELS.

Citadels are small fortresses, usually of 4 or 5 fronts. They are raised in fortified towns to secure the possession of them, in case the inhabitants revolt; and to furnish the garrison a retreat, if threatened by them, from which they may punish their rebellion. They also receive the remains of the garrison when the town is taken, and compel the enemy to undertake a second seige. They thus furnish the means of reoccupying the town if assistance arrive.

The citadel should be large enough to accomodate the remains of the garrison. This may be estimated at three fourths of the original number, of which one fourth are probably in the hospital. It should be provided with bomb-proof lodgments sufficient to contain every thing necessary to enable this garrison to sustain as long a siege as the strength of the fortification will admit. (*Bousmard*, vol. 3.)

When the citadel is adjacent to the fortifications of the town, its covered way should be separated from the houses by a large esplanade, so that they may not favour the enterprises of the enemy. When the citadel is without the town, it is connected with it by lines of communication, and the fortification of the citadel should possess an influence over that of the town.

In great fortified towns, which have no citadel to oppose rebellion, or awe the inhabitants, one or two bastions are intrenched at the gorge, and thus become reducts for the garrison, and fortifications against the people.

OF DEFENSIVE CASEMATES AND GALLERIES WITH LOOPHOLES.

Defensive casemates are vaults established under the mass of the works. The front wall is pierced with embrasures for cannon. Casemates are useful only when they are so placed as to have a current of air throughout. Without this precaution, there will be a suffocating smoke, when the guns are used, that will not permit the defenders to remain, or will impede the service of the guns. The thickness which must be given to the front wall to enable it to withstand the enemy's artillery, does not allow the mouth of a cannon to project beyond it, the smoke, therefore, is

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not thrown to the outside. This inconvenience has caused the abandonment of casemated bastion flanks; but there is no doubt, that when a circulation can be obtained, by creating a current of air, either through openings on the sides, or in the vaults, casemates are a good defence. Flank and front fires entirely out of the reach of his projectiles, are obtained by means of them, against the enemy.

Crenelled Galleries, or Galleries with Loop-holes, are small casemates provided with loop-holes for musketry; they are usually 8 feet wide and 7 high, to receive two ranks of soldiers, one of whom loads and the other fires. Openings are made in the vault for the escape of the smoke. These galleries are valuable to defend a ditch which is not otherwise flanked; they are made in the body of the scarp, and along the whole counterscarp, to produce both flanking and reverse fires. When the work is of importance, a piece or two of cannon, of small caliber, is placed in them.

OF THE DEFENCE AFFORDED BY WATER.

Water may be made great use of in the defence of places, either by contriving the ditches in such a way that they may be drained, or filled with water at pleasure; or by forming inundations in front of one or more of the fronts, which may render them inaccessible. In the latter case, the force of the garrison may be diminished, for the parts thus rendered inaccessible have need of a very slight guard only.

Much trouble and loss may be caused to an enemy by means of sluices, drains, &c. which raise the water above its ordinary level so as to inundate the ground on which he pushes his attacks.

Even if the enemy can drain an inundation, it would still be useful, because it always delays his works, and renders the construction of his trenches, in the muddy ground it leaves, very difficult.

OF MINES AND COUNTER MINES.

A small chamber formed under the earth at the revetment of a

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work which is to be blown up, is called a *Mine*. The subterranean passage which leads to the mine is called the *Gallery*, and the spot where the powder is placed, the chamber or furnace of the mine.

Constructions of this kind, when made by the besieger, were called MINES, and those made by the besieged COUNTER MINES. But at present the mines of the besieger are styled *Offensive*, and those of the besieged *Defensive Mines*.

The art of mining, in the attack of places, was known to the ancients. The besiegers endeavoured to introduce themselves into cities by subterranean communications; they also overthrew the walls by digging beneath them; their weight was supported upon stancheons, until the moment of attack, when fire was set to them, and the walls being no longer sustained, suddenly fell. The besieged also used subterranean galleries. They prepared an envelop under ground, in front of their walls, to cut off the subterranean march of the besieger, and meet him in his progress; they made galleries to pass under the towers, and other machines he employed to command or destroy the works of the place.

Gonsalvo de Cordova first employed gunpowder in mines; in the year 1503, he made a breach in this way in the Castle del Ovo, built upon a rock, in the kingdom of Naples, and took it.

The art of mining rests upon the following principles: when a mine is formed under a horizontal piece of ground, the explosion takes effect in the direction of the vertical line *p s*, (fig. 60.) reaching from the surface of the ground to the centre of the powder, because there is a less thickness of earth in this direction. This line is called the line of least resistance. The gallery must be strongly rammed, for an extent greater than the line of least resistance, so that the powder may not act in that direction. Experience has proved that it should be filled to a distance double the line of least resistance, so as to supply by the quantity of earth, the tenacity that earth lately stirred wants. The hole made by the explosion is called the *entonnoir*, crater or funnel. It is in the form of an inverted conoid, like *d a d*, fig. 60. The diameter *d d* of the base of the conoid, which is the outer opening of the funnel, is in ordinary mines equal to twice the line of least resistance. This diameter increases or diminishes with the charge of powder. The earth, which is thrown up at the moment of ex-

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plosion, falls partly back, and the rest upon the edges forming the figure *l o l* nearly.

In consequence of the effect produced by the power of a mine, in the direction of the earth that offers least resistance, it is evident that the besieged may destroy the action of the besieger's mines by means of galleries and countermines.

The besieger may also break into the gallery of the enemy's mines, deprive him of air, and cut off his retreat. This may be done by a small charge of powder lodged in the side of the gallery, and is called applying the *Camouflet*.

These means of obviating the effects of the enemy's mines being acknowledged, subterranean galleries were established in fortresses under the glacis of the fronts exposed to attack. They also furnish the means of blowing up the batteries in breach. These countermines took away from the attack a part of the advantages it had drawn from the use of mines. The besieger was compelled to advance with circumspection, to search for the countermines which surrounded him, and could no longer approach with the same facility to throw the counterscarp into the ditch by his mines.

But the discovery made by the celebrated Belidor of the effect of overcharged mines, called *globes of compression*, restored the superiority of the attack.

"Belidor observed, that when a mine exploded, and threw up the ground over it, its action was at the same time felt in a circular direction, throughout the surrounding ground, to a distance at least equal to the oblique line *p d* (fig. 60.) drawn from the centre of inflammation to the edge of the funnel. He named the mass thus compressed by the action of the mine, *globe of compression*.

The tenacity of the earth almost always gives way before all the powder is inflamed, and all that can be expected from the most overcharged mine, in soil of ordinary texture is, to form tunnels whose greatest diameter is 6 times the line of least resistance, and to cause its lateral action to be felt under ground to a distance four times the length of that line.

"Such was the result of the theory and the experiments of Belidor upon mines. From this time the besieger knew that he could choke up the galleries, and overthrow the counterscarp of the besieged, at a distance four times as great as that at which

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he had previously thought them assailable, and that he could destroy works above the surface at three times the distance he would have formerly thought them attackable.

The globe of compression has never yet been used in the defence of places, for fear of forming tunnels so large as to afford great shelters for the besiegers close to the fortress; and also because they consume enormous quantities of powder, which is often of great value to the besieged, who cannot procure fresh supplies. It may also be observed, that the besieger can only employ it at a distance for fear of destroying his own defences.

"The charges of mines for producing cones of the ordinary size, with bases twice the line of least resistance in diameter, in sandy soil, are as follows, in French weights and measures.*

Length of the line of least resistance. *fest.*	Quantity of pounds for the charge. *lbs.*	*oz.*
1	0	2
2	0	12
3	2	8
4	6	0
5	11	8
6	20	4
7	32	2
8	48	0
9	68	5
10	93	12
15	316	4
20	750	0
25	1558	9
30	2530	0
35	4019	8
40	6000	0

* As the French foot bears the same proportion nearly, to the English, as the French pound to the English pound, this table will serve, without material alteration, for our common weights and measures. Tr.

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"The charge ought to be augmented $\frac{1}{11}$th. in ordinary soil; $\frac{4}{11}$ths. in tough ground; $\frac{5}{11}$ths. in clay; $\frac{7}{11}$ths. in masonry; and $\frac{9}{11}$ths. in rock, if they are to be blown up, instead of sandy soil.

"*Belidor* gives the following rule to ascertain the charge necessary for a globe of compression, whose funnel shall have a base 6 times the line of least resistance, and powerful enough to destroy all the galleries and branches of mines within four times that distance; multiply the line of least resistance, expressed in feet, by 300; the product will be the weight of the charge in pounds. Thus, if the line of least resistance be 12 feet, the charge of the globe of compression will be 3,600 pounds of powder.

"If a mine be wanted, whose funnel shall be the smallest possible, or if it be only desired to overthrow some of the works of the besiegers by a violent trembling of the ground; it is evident that the charge of the mine must be lessened." (*Bousmard*, vol. 2.)

SYSTEM OF COUNTERMINES.

The disposition of galleries, prepared under the glacis of a place for the operation of the several mines intended for its defence, is called a system of countermines. (fig. 59.) There are several sorts of these galleries. First; that which extends below the covered way, and from which branches are pushed to overthrow the works and batteries of the besieger, that crown it; this is called the *Magistral Gallery, m*, or gallery of the counterscarp. There is, secondly, another grand gallery nearly parallel to the first at the distance of from 40 to 60 yards; it is named the *Enveloping Gallery, e;* it communicates with the other by passages, which are styled *Galleries of Communication, c.*

Other galleries are pushed still farther forward into the country, leaving the enveloping gallery, and projecting at least 30 yards. They have spaces between them of about 50 yards in width, so that the enemy's miner, whose work may be heard under ground about 30 yards, may not pass between any two of them without being discovered; these are called, from their object, *Listening Galleries.* From these galleries, branches are carried forwards to establish chambers under the works of the enemy.

The passages that lead from the powder to the communications, or to the great galleries, are called *Branches.* Behind this combi-

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nation of galleries destined for the defence of the counterscarp, there are others under the scarp of the works. The principal of these is in the interior, and along the faces of a bastion or half moon; it is called *Major*, or *Scarp Gallery*. It is nearly on a level with the bottom of their ditches, and has openings for branches across the foundation of their revetments, which may answer to intercept the enemy's miners, or to form mines under the rubbish of breaches made by cannon. When the bottom of the ditches is perfectly dry, galleries of communication may be carried beneath them, from the Scarp Gallery to that of the counterscarp, and branches by which the epaulment of the passage of the ditch may be blown up. (*Bousmard.*)

Combined mines are those whose chambers are nearer to each other than the line of least resistance; they are employed when it is wished to fire several furnaces at a time, in order to tear up the ground completely at a single blow. They are disposed in pairs, by threes, &c. according to the object in view.

Isolated mines are those which are to produce their effect separately. They should be separated from each other at least twice the distance of least resistance. Several of them may be set-off together to embrace a large extent of surface without tearing up the ground entirely.

Mines are also disposed at different depths, or in several different horizontal planes, so as to remove some particular point, on which the besieger is determined to establish himself, and from which he ought to be often dislodged.

The reader may easily form an idea of the proceedings of the besieger and the besieged, in this subterranean war, where the object of both parties is to listen, to seek, and to surprise each other; and mutually to cut off the other's retreat, or stop his progress by means of mines and camouflets. The besieger having it for his object, to prevent the besieged from penetrating beneath his lodgments and batteries, to destroy the counter-mines, and enter them in order to drive the besieged out. The besieged, on the other hand, makes every effort to envelope the subterranean labours of the besieger, and to defend the counter-mines. He barricades himself, from distance to distance, in the galleries, by gates and little wickets, and throws grenades, small leather sacks full of powder, &c. to incommode the enemy.

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A celebrated engineer (*Bousmard*) estimates the delay a subterranean war, under a well countermined glacis, would cause to the capture of the place. The total amount of resistance might be increased to three months, when the system of mines extends to every part of the fortification, that the besieged is obliged, in consequence, to attack successively.

We have still to give an idea of the mode of constructing the galleries, and springing the mine. When a mine is to be made, either for the attack or the defence, the first operation is to dig a shaft *p* (fig. 62.) to the level at which the gallery is to commence; unless there be a ditch or gallery already formed at this depth, from which the subterranean road may at once be opened in its proper direction. When arrived at a suitable level, the gallery *g* is dug towards the desired point, until the place destined for the powder is reached. There the chamber is formed on one of the sides of the gallery; beneath it, if the ground is dry, or above if it be wet, so that in the latter case, the water may run off by the gallery of communication. The powder is enclosed in a cubic box of wood, and the chamber is made of that figure, of the proper size. To determine its dimensions, it is sufficient to know that 75 pounds of powder occupy a cubic foot.

While the shaft is digging, the sides are supported by frames of wood. The first frame (fig. 61.) is placed on the level of the ground; when the miner has penetrated three feet, he places another, and forces planks between the earth and the frame, and so on to the very bottom of the shaft. The same process is pursued in digging the gallery or branch *g*. Shafts are made from time to time to enable the air to circulate freely; they are from 3 to 6 feet square. "The principal galleries of a fortress are constructed of masonry; they are 6 feet high and 3 in width. Galleries of attack are $4\frac{1}{2}$ feet high by $2\frac{1}{2}$ to 3 in breath. Branches are $2\frac{1}{2}$ to 3 feet high by 2 to $2\frac{1}{2}$.

"To charge, ram, and fire a mine. The box being placed in the chamber, a conduit of wood *a*, called the trough, is placed in the gallery, and passed into the center of the box through a hole made for the purpose. This trough is nothing more than a spout composed of 4 boards nailed together, that form an opening of an inch square to receive the *saucisson*. The saucisson is a long bag of linen 9 or 10 lines in diameter, filled with powder for the pur-

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pose of communicating fire to the mine. The saucisson having been placed, the top of the trough is fixed on, the chest is filled with powder and closed up; the vacuity round the box is filled with sods, sand bags, (fig. 64.) &c.; the chamber is shut by a small door of timber, and reinforced by pieces of wood supported against the opposite side of the branch upon pieces of plank. This done, the gallery, or branch of the mine, is well rammed with earth, wood, &c. to a distance from the chamber equal to twice the line of least resistance.

"As it would be dangerous for the person who fires the mine, to place himself at the end of the rammed gallery, the following method is used to save him. Care is taken to make the end of the saucisson project a short distance from the trough, and to fix it upon a piece of plank; a small hole is made in it, and a little powder spread upon the plank; the end of the saucisson is then covered with a piece of paper, through which is passed a bit of tinder of the size of a quill, and three-fourths of an inch in length. The paper is kept down upon the powder by small stones placed over it, it is then covered with dry and fine earth surrounding the tinder. The earth will prevent any sparks from reaching the paper, when the fire is brought near, and the powder from being inflamed in consequence. The piece of tinder is called a monk, in the language of miners, and permits him who sets fire to it to retire before the powder inflames.

"When it is proper to seize without delay some precise moment to use the mine; for instance, when in an assault it is desired to spread destruction through a crowd of the assailants, collected for an instant within the sphere of the activity of the mine, the lock of a gun or pistol may be employed. The trigger of this is drawn from a distance by means of a thread. A piece of board sliding in grooves made in two strong planks may also be used; it is made to rest upon the hole in the saucisson, an inflamed match is placed over it, which falls when the board is pulled away by a string.

"The difficulty of executing the ramming of the gallery in case of haste, has led to a search for means of avoiding this labour either wholly or in part. Major Mouze, of the French engineers, has discovered, that if the charge of powder is augmented one fourth, the length of ramming may be reduced one third, and if the charge be doubled, it may be altogether suppressed. (*Bousmard.*)

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OF FOUGASSES.

Small mines called *fougasses*, are made use of in the defence of field works. Chambers of mines which are not sunk far beneath the surface, (10 feet at most,) are so called; *f* (fig. 63.) They are placed at the expected points of attack, usually 9 feet from the salient angles, and without the counterscarp. To prepare a fougass, a shaft *p* is dug 3 feet square and of the proper depth, the chamber is formed by digging upon one side of the shaft a space to contain the chest or barrel of powder *c*. From this spot a trench, or a branch open at top, is dug for the purpose of placing the trough that contains the saucisson. This trough must communicate with the interior of the work beneath its parapet, or if that cannot be done, with the ditch. All the excavation is then filled up with earth well beaten down. The adjoining ground is often ploughed in order that no particular mark may indicate the place of the mine. To produce greater destruction among the assaillants, part of the excavation may be filled with stones or pebbles.

OF DEFILEMENT.

The operation by which the crests of the parapets of a work are so disposed, that its interior may not be seen from heights surrounding it, is called Defilement.

To arrive at this result, the crests must be in a plane that passes at least 7 feet above the most elevated point that can be found, within a distance of 1200 yards.

By this process, which belongs to Descriptive Geometry, and has its particular rules, an engineer determines the relief that must be given to the several works, in order to erect a tenable and strong fortification, upon ground which is commanded.

OF SYSTEMS OF FORTIFICATION.

By a System of Fortification, we understand the method invented by one engineer, and adopted by others, for the uniform fortification of places. In a word, it is a newly invented combination of lines and angles, of ramparts and ditches.

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Bastioned fortification made its appearance in the 14th century, it was confined for a long while to very small bastions. Errard, in his treatise on Fortification, in 1594, laid down its principles; he regulated the extent of front by the range of the musket, and adopted a regular manner of tracing the outline; he made orillons, a small covered way, and sometimes a little half-moon, then called a *ravelin*. (fig. 46.)

De Ville, about 1630, perfected the bastioned front of Errard; (fig. 47.) he made the flank perpendicular to the side of the polygon instead of letting it make an acute angle with the curtain. About this time a variety of opinions produced an infinite number of methods of fortification, of which, however, the greater part had but few essential differences from each other. They were all afterwards united into four classes, called the French, Italian, Spanish, and Dutch systems, from the names of the people to whom they were peculiar. The difference between these systems was principally in the opening of the salient angle of the bastion, and in the direction of the flanks. The bastions were small in all of them, and did not permit the display of troops or the manœuvres of artillery; the flanks were ill directed; and every part of the front, without exception, might be battered in breach, because the body of the place was covered by nothing but a feeble ravelin.

Pagan, who came next, made his flank perpendicular to the line of defence, or to the direction of the ditch; (fig. 48.) he substituted low, for casemated flanks; he increased the size of the half-moon; he discarded from his system those trifling minutiæ of trace with which former ones had been incumbered, and brought fortification nearly to the state in which it now is, and which the celebrated engineers, who have since appeared, have only contributed to complete. Among them may particularly be reckoned Vauban and Cohorn, who were cotemporaries and rivals about the year 1655, and Cormontaigne, of whom we have already spoken.

Vauban, in order to reduce the length of the lines of defence, diminished the side of his polygon to 380 yards; he enlarged the bastions and made retrenchments within them to sustain the assault; he invented the tenail to cover the curtain, the postern,

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and the flanks; to defend the gorge of the half-moon; and to protect the retreat of the troops which defend it; he enlarged the half-moons, and made them cover the shoulders of the bastions; he then suppressed the orillon, and made reducts in the half-moon; he improved the covered way by increasing its width, intrenching it by traverses, and establishing places of arms large enough to contain reducts covered by small ditches. Vauban, in addition, perfected the means of attacking fortresses which are now in use.

Cohorn, in his system, sinks the level of his covered ways and dry ditches as deep as can be done without meeting water. The besieger, therefore, cannot make lodgments upon them without bringing materials, and suffering from the length of, and multiplied difficulties attending, this species of labour. This condition can evidently be attained only in wet ground, or in those plains which are not elevated more than 4 feet above the ordinary level of the water. Such is the soil of the greater part of Holland, the country of the author.

Situations of this sort are necessary to his system, to enable him to surround his several works, some with dry, some with wet ditches; by which he gives the works they surround the advantage of not needing a revetment of masonry, and yet being, on that account, more difficult to breach by cannon. He narrows the ground on which the enemy must place his counter-batteries, so much, that he must carry thither considerable quantities of materials. He established casemated batteries, and sheltered fires of musketry. This system, which draws its chief advantages from its site in wet ground, opposes a vast number of obstacles to the besieger. Cohorn is also the inventor of the small mortar for throwing grenades, which bears his name. This mortar, which is very light, may easily be employed in every possible direction that it may be needed, and multiplied to any extent. In the near attack, it destroys the defenders of a work by a great quantity of projectiles, which, though small, are always deadly. (*Bousmard.*)

Cormontaigne, whose system we have detailed, as the most useful, did no more than rectify the system of Vauban. He made large half-moons advancing into the country in order to see

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in reverse the crowning of the covered way. He made within them a good reduct with flanks. He made reducts in the places of arms to make their defence more obstinate. He discovered the property possessed by several fronts upon one straight line, or of a front making very obtuse angles with the two adjacent fronts, which compels the besieger to attack two half-moons for each bastion. A front of this sort also affords converging fires formidable to the besieger, forces him to employ more means of attack, and to take greater precautions in the conduct of his saps.

Among the modern authors who have published systems of Fortification, is General MONTALEMBERT, who replaces the bastioned figure by that with tenails, whose salient angles are 60 degrees, and the re-entering angles 90 degrees. It is this figure which has given his fortification the name of Perpendicular, because the lines of defence are, in fact, at right angles to the faces. He makes great use of defensive casemates, which he regards as the basis of his system.

General CARNOT in his system employs the tenailed figure, with a casemated bastion-tower on each salient, and casemated batteries of two tiers, in each re-entering angle. Like Montalembert, he makes great use of sheltered and casemated batteries.

BOUSMARD curves the flanks and faces of his bastions, he makes the tenail with flanks, that have each a casemated battery open to the rear for the passage of the smoke; he covers the cheeks of the embrasures with fascines, to avoid the inconvenience arising from the splinters of the masonry; he makes a vaulted passage along the caponnier, between the banquets on which the defenders stand, &c. (See his *Essai General de Fortification.*)

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OF THE ATTACK OF FORTRESSES.

PREPARATIONS FOR THE SIEGE.

The commander of the artillery ought to be among the first who is informed of the intended siege. He assembles the supplies of cannon, carriages, projectiles, gunpowder, equipments, &c. with the greatest secrecy. This should be done in those fortresses nearest to that which is to be besieged; unless it be thought better to make arrangements to transport them from more distant places, in order that the enemy may not be advised of the design by seeing the formation of depots in his neighbourhood. It is necessary that this officer should know the strength of the place, and the time that it will probably hold out; in order to calculate the number of cannon, the quantity of ammunition, stores, and equipage, that will be needed. It is also important that he should combine the loads of the several convoys, and their march, in such a way that each article may arrive as it is wanted. This is not among the least of the anxieties of a commandant of artillery, in consequence of the constantly augmenting difficulties that arise from the distance, the quality of the roads, the ill will of the inhabitants of the country to be passed; and many other circumstances, that will cause delay, unless they have been foreseen, and prolong the duration of the siege, from which disasters cannot fail to arise. (See *Equipage of Siege Artillery*, 2d vol.)

Of the Force of the Besieging Army.

The force of a besieging army, depends upon the Topographi-

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cal situation of the place; on the nature of the fortifications; on the number and vigour of the garrison; on the hostility to be expected from the outside; and, in fine, on the circumstances of the war.

If only a blockade is intended, the numerical force is regulated by the nature and the number of the outlets, through which the enemy might sally out; by the efforts that are to be expected from enemies attempting to raise the blockade from without; and by the importance that is attached to keeping the garrison enclosed with narrow limits.

But if the besieging army intends to form a regular siege, the numerical force for this single object depends on the labour to be performed; on the number of troops required to oppose sorties; and on the rapidity with which it is intended to urge the operations of the siege.

As regards the troops that are required for the siege *proper*, the calculation has for its elements the following objects: the guard of the trenches; the service, movement, and transportation of the artillery; the preparation and transportation of the materials for the works, and the erection of them; the guard of the lines; escorts; detachments for provisions and forage; and the probable losses in sick, wounded, killed by the enemy, or dead of disease.

Hence it may be seen, that the siege of every particular place requires separate calculations, in order to fix the force of the besieging army; and that this cannot be regulated upon the force of the garrison, as many authors declare. Some of these lay down for a general rule, that the besieging army shall be four times as numerous as the garrison; but a few examples will show how erroneous all such calculations are.

In 1807, the French besieged and took Dantzic; they had an army of 12,000 men; the garrison was quite as numerous; but the great French army was at that time in Old Prussia, opposed to the armies of the enemy, and the besiegers had nothing to apprehend from operations against their rear.

In 1809, the famous siege of Saragossa shows us a French army that had to contend with the entire population of several provinces; and yet besieging and destroying, in a fortified city, an army much more numerous, and full of enthusiasm, excited and kept up by the priests and women; an army that defended itself manfully,

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after the loss of its ramparts, from house to house, and from room to room; this city had a garrison of 30 or 35,000 troops of the line; 15,000 peasants, who aided in the defence with still more ardour than the regular troops; 150 pieces of artillery in battery; all the necessary supplies; and a chief possessed of the general confidence. It was besieged by a French army of 31,000 men, and 60 pieces of battering artillery; only 24,000 men were employed directly against the place; the rest of the army was engaged in scouring the country, to disperse the meetings of the enemy for the purpose of troubling the siege, and intercept their convoys. It was taken, and the whole garrison made prisoners 52 days after the trenches had been opened; 29 of these were required to enter the place, and 23 taken up with a war from house to house.* This siege shows what may be done by a good army, knowledge of the Art of War, and Military Talent.

Principal periods of the Siege.

There are three periods to be distinguished in the attack of a fortress. The first begins with the investment, and continues until the opening of the trenches; the second extends from the opening of the trenches until the formation of a lodgment at the foot of the glacis, which is called the third parallel; and the third, from the completion of the third parallel, until the end of the siege.

FIRST PERIOD.

Of Investing and Reconnoitring the place.

The investment is the first operation of a siege; it consists in suddenly throwing upon all the communications between the place and the country, bodies of troops, that at once hinder the entrance of succour, and departure of any advice of its situation. It ought to be made as secretly and rapidly as possible, because the place

* These facts are taken from the relation of the siege of Saragossa, by the French General Rogniat, and that of the Spanish Lieut. Col. Don Manuel Cavallero.

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may not be fully supplied with stores and provisions, and it is important that it should be prevented from receiving them from the neighbouring fortresses, or collecting subsistence from its own environs.

The columns of the investing corps take a position out of the reach of the cannon of the place, and in such a way as to prevent the passage of any assistance; detachments are pushed, from their head, as near to the place as possible, that carry off every thing portable in its vicinity, even the inhabitants themselves, who can almost always give information as to the actual state of the fortification, troops, stores, and provisions. A chain of little posts is then established as near the place as can safely be done, the sentinels of which can discover every thing which passes out from it. As the night is most favourable to the escape of persons bearing information, these posts are brought, during it, within 1200 yards, or even less, of the place. They fall back during the day to their original position, which is called the *Cordon of the Day*; the other, *Cordon of the Night*.

The corps, drawn from the army, destined to carry on the siege, to form the investment, is composed of cavalry, infantry, and artillery, in proportions suited to the nature of the ground, and calculated for rapid movements. Some military writers fix its force immutably at 5 or 6000 men, but it is evident that it must be proportioned to the strength of the place and the nature of the country that surrounds it, nor must the facility or difficulty, with which the several parties may communicate with each other, be forgotten in the calculation.

The officers, charged with making preparations for the *reconnoissance*, the general ought to make, before the main body of the army arrives, march with the investing corps. He will, with their aid, make choice of the front to be attacked, and provide for the defence of the besieging army, as well as of the army of observation, (if there should be one,) and fix the location for the Park of Artillery. The point to be attacked must be determined upon before the Park is placed, that it may never be necessary to remove it after it is once established. To remove the park would cause both delay and expense, while it is essential to the progress of the attacks that it should be near them.

The besieging army, which ought not to lose sight of the corps

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that forms the investment, usually arrives about the fourth day, and takes up its position. In order that the camp and parks may not be troubled by the artillery of the fortress, they should be farther from it than the ordinary range of the heaviest gun, say not less than 3,000 yards. (A 24 pounder, at an elevation of 45 degrees, carries a ball 4,800 yards, but it is not probable that the besieged will take the trouble to give such a direction to his guns, as he cannot do it without taking them off their carriages.) The powder should be beyond the reach of the heaviest mortar, which is not less than 4,300 yards. In order to provide for the safety of the camp, intrenchments are erected towards the country, and also towards the place, in order to restrain the attacks that may be feared from that side; the parks especially ought to be well covered by works.

Lines of Circumvallation. The camp of the besieging army is sometimes covered on the side farthest from the fortress by continuous lines, of a figure nearly circular, called Lines of Circumvallation. (pl. 6.)

Lines of Countervallation. When the garrison of the place is so numerous, that it can act against the camp of the besiegers, either separately, or in aid of a relieving army, a line of countervallation is sometimes established whose defences look towards the place. It often happens, that instead of this continuous line, only a few detached works are erected in advantageous situations, to guard against the enterprises of the garrison of the place.

Opinions are much divided as to the value of Lines of Circumvallation, and it may be said that they are now no longer used. If a besieging army is shut up in lines, it may be compelled to leave them in order to fight, even when the relieving army dare not attempt to force them. This will happen if it be blockaded, and all its convoys intercepted; if it cannot preserve a secure communication with some point whence it can receive supplies, and has not a sufficiency of food within the lines. In such a case, lines are useless. It may, however, be said in their favour, that they serve to intercept all partial relief, and to prevent sudden attacks; that they will give the besieger time to receive reinforcements if not distant, that they can do no harm, and may perhaps do good. If

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lines of circumvallation are not constructed, intrenchments must be erected on those points that are most likely either to prevent attack, or hinder the passage of stores, provisions, or troops.

Six hundred yards must be left for the establishment of the camp, between the lines of counter and circumvallation, in order that there may be 250 yards for manœuvring both in the front and rear of it. The communication, from one part to another of the space enclosed, must be rendered easy by throwing a sufficient number of bridges, over the rivers and brooks that may intervene; making roads of fascines over the marshes, &c.

If the extent of the circumvallation be from 25 to 30,000 yards, it may be constructed in 8 or 10 days by 12 or 15,000 labourers, drawn either from the army or from the inhabitants of the country. The lines of countervallation, and those detached works which are to confine the garrison, are made during the same time.

While all this is doing, the fortress is more particularly reconnoitred, in order to choose the point of attack, and the site of the park of artillery.

Choice of the Point of Attack. In order to determine this point, it must be ascertained which front of the place may most easily be envelloped by the trenches, is most exposed to enfilading or reverse fires, or to be opened by direct fires. This will most probably be the most salient part; unless it is supported on each side by inaccessible points, that do not permit the besieger to extend his attacks, and take positions on the prolongation of the faces of the works; or is situated behind an inundation; or upon bare rock. Re-entering angles should never be attacked, as the enemy may then take the trenches in flank, or cross his fires on the head of the works of attack. Attacking a front which is so combined with others, that the fire of the whole may be directed against the attack of any one of them, is to be avoided; as should also approaches exposed to the fire of works not liable to the action of the ricochet, and only exposed to a direct fire, which is much less destructive.

The trenches ought not to be opened in very rocky ground, in that which is marshy and cannot be drained, or in that which is commanded by the works of the place. It ought, if possible, to be ascertained by means of spies or deserters, whether the glacis

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be counter-mined; whether the ditches are so deep and so narrow, as to prevent the wall from being battered so near its foundation, as to permit an ascent to the breach over the rubbish; and whether the besieged may not fill the ditch at pleasure, or inundate the ground where the attacks are to be constructed, by means of reservoirs and sluices.

When a fortress may be attacked with advantage in more than one place, the choice is usually between some two of its fronts, for it rarely happens that there are three points that offer nearly equal advantages. It, therefore, remains to examine these points more closely, in order to discover that which is weakest and most favourable to the besiegers purposes. This may be done by seeking for faults in the figure, and relief of the fortification; for those faces on which the ricochet may most easily act; for the side where there are the fewest works to be taken, and the ground is most favourable for the approaches.

In reconnoitring a place, the artillery officer should pay his chief attention to the scite of the batteries; their distance from the place; the effects they will most probably produce; the difficulties of constructing them; and the means of overcoming those difficulties. There should be a strict relation between the service of the artillery and the labours of the engineers; for it must not be forgotten that the latter can neither advance nor be supported but by the fire of the former.

On this account, a trifling additional difficulty in the approaches, is not a sufficient reason to abandon a point of attack that would furnish the artillery with favourable positions.

The park should be placed as near the works of the attack as possible, in a place easy of access for carriages, and near to water, which is necessary for the innumerable animals, without whose aid its movements cannot be effected. If it be placed near a river care must be taken to ascertain if floods are to be feared, and their greatest extent, so that the park may not be exposed to inundation.

In reconnoitring, notice must be taken of wood fitted for the fabrication of saucissons, gabions, and of such as may be applied to making platforms. If this can be procured in the neighbourhood, or purchased in the woods, it will considerably diminish the quantity of siege equipage that must be drawn from a distance.

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The position of the park being determined on, the director marks the places for the guns, for the carriages of every sort, and for the projectiles, in order that they may be properly arranged as they arrive. He establishes the powder magazines in those places where they will be most secure, and fixes the location for the work-shops of the wheel-wrights, smiths, and artificers. (See *Castrametation.*)

As soon as this is done, the manufacture of the saucissons, gabions, and pickets, necessary for the construction of the batteries, is begun. (The engineers attend to the making of the fascines, gabions, sap faggots, &c. which are required in the trenches.) These articles are prepared by the inhabitants of the country in the nearest woods, and also by the soldiers of the army, whom the artillerists and sappers teach the business in a very short time.* There is an enormous consumption of them during a seige. When finished, they are carried to *depots*, or little parks of artillery, in the rear of the ground where the attacks are to be opened. These depots are not more than 1200 yards from the place, and are sheltered by hills and other accidents of the ground; they should, if possible, be on the prolongation of the capitals, so as not to be exposed to the fire of the artillery, (fig. 68. *d d.*)

The position of the first batteries being fixed, the prolongation of the faces of the works necessary for their trace, is taken, and each of the lines thus formed, marked by two strong pickets, called, station pickets. These are numbered and planted in the lines of prolongation at the distance of 50 yards from each other. If the exact prolongation of the covered way of the face, against which the battery is to be established, can be found, it must also be marked by pickets, that will show the proper places for the guns intended to fire *ricochets*, to sweep off its palisade, and destroy its defenders.

The commandant of the artillery names those officers who are to conduct the labours of his corps, in pushing the attack. One of these must be constantly in the trenches, to inform him of every thing that passes there, watch the motions of the besieged, receive

* In Germany each fascine was found to cost about three cents, and the gabion nine cents.

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orders, and transmit them to the commandants of batteries. He must also have an officer constantly stationed in the central depot at the opening of the trenches, whither the officers commanding batteries repair to procure what they are in need of, and where the ammunition for each day's use is placed, to be distributed to the troops. This depot is supplied from the great park.

The director of the park must in like manner arrange his service into several departments, and place active and intelligent officers at the head of each.

The officers of engineers make a plan of the front of attack, including all the works that can act against the approaches; on this is drawn, with as much exactness as possible, all the accidents of the ground, the thickness of the parapets, the breadth of the ditches and covered ways; on it are also traced the prolongations of the faces and capitals of all the works; these should also, as we have just seen, be marked carefully on the ground;—It shows also the position of the station pickets, and their distance from the salient angle of the covered way.* This plan, the details of which are most minute, is called the directing plan of the attack. Upon it are drawn in succession the operations of the siege.

All this must be done during the first period of the siege, or previous to the opening of the trenches; an operation that should not be undertaken until all the materials necessary to complete it are assembled, together with every thing wanted in the construction, armament, and equipment of the batteries; or at least until

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* To measure the distance from a salient angle of a besieged place to one of the parallels, or to the camp of the besieger:

Let *a* be the point (fig. 66. pl. 6.) whose distance is required; place a picket at the point *b* where you stand; to the line *a b* draw a perpendicular *b c*, (some hundred yards in length, if possible, particularly if the distance to be measured be great;) at the extremity *c* of this draw *c e* perpendicular to it. In *b c* take the point *d*, so that *d c* may be some aliquot part of *b d*, such as the half, the quarter, the tenth, and plant a picket there; then retire in the direction of the perpendicular *c e* until you mark the point *e*, where you see the picket *d* in a line with the point *a*; plant a picket at this point of the line *c e*, and measure *c e*; that done, *a b* will contain *c e*, as often as *b d* contains *c d*; so that if *e d* be the tenth of *b d*, the line *c e* will also be the tenth part of the distance *a b* which is sought. (This method also serves to measure the breadth of a river, as is shown in the lowermost figure.)

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it is certain that whatever is not entirely ready, will be prepared by the time it will be needed. It would be much better to delay opening the trenches than to be exposed to delays while carrying them forward, for this would not only waste at least an equal time, but would most probably cost a number of valuable lives.

Care must be taken that nothing points out where the attack is to be made, nor where the depots are to be established; demonstrations made on every point susceptible of attack will keep the besieged in suspense.

The depots of the trenches being furnished with fascines, gabions, and saucissons; with mattocks, spades, saws, levels, and other tools for the workmen; in fine, with every thing necessary for the construction and daily repair of the batteries; the park being provided with cannon, stores, and ammunition, and all the equipment necessary for the first batteries; every thing, in short, being ready for opening the trenches; the general fixes the day when this operation shall be performed.

Before we proceed farther, it is proper to explain the form, position, and use, of the trenches of communication, and of the parallels.

The trenches of communication, (*boyaux*,) *z z*, (pl. 7. fig. 68:) are nothing more than ditches cut in a zigzag form, cautiously approaching the works of the place. They open from the depots *d d d*, of the trenches, and are made 3 feet in depth, 6 feet wide at bottom, and 11 feet at top. In front of this ditch, and about a foot from its berm, the excavated earth is thrown, forming a parapet $4\frac{1}{2}$ feet high, (see profiles, fig. 69 and 70,) and sloping in the direction of the line *l i*, in those which form the communication between the first and second parallel, and of the line *o q*, in the communication from the second to the third.

These saps are pushed forward in the direction of the capitals, because the ground in front of them is the least exposed to the fire of the place; and because they do not there mask either the enfilading or direct batteries. They are of a zigzag figure, in order that each part of the trench may be directed to a point not within the works. This preserves them from enfilade. If this were not done, or the approaches made in a straight line, it is clear that they would be exposed to this kind of fire.

In order to protect these zigzag approaches, a trench is made

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parallel to the place, to oppose a continuous front to the sorties of the besieged, and thus sustain the workmen and the batteries. As this trench is intended to contain the troops acting on the defensive, it might be called a place of arms, but from its direction it is styled a *Parallel*. *a a*, *b b*, *c c*, are parallels. (pl. 7. fig. 68.)

In consequence of the destination of these parallels, they are made with a banquet behind their parapets, so that the troops may fire from it. A parallel is then a ditch 3 feet deep and 7 feet wide at bottom, in front of which the earth is thrown, making a parapet $4\frac{1}{2}$ feet high, and leaving one banquet of 2 feet in width, and another beneath it of $1\frac{1}{2}$ feet. The breadth of this trench at top is 16 feet, because the slope towards the country must be very gentle, in order to permit its being easily descended and re-mounted. (See Profiles, fig. 71 and 72, where the line *g f* shows the shape of the first parallel, and *g h* that of the second and third.)

Three parallels are established in succession, at the distance of 300 yards from each other, so that the troops lodged in them completely protect the progress of the saps and trenches of communication, as well as the batteries intended to silence the fire of the besieged. The first parallel is usually drawn about 600 yards from the salient angles of the covered way. It will have then but little to fear from the fire of grape shot, and nothing from that of musketry. This distance is not, however, scrupulously observed, each parallel is planned in such a way as to take into its circuit the points that are most favourable to its defence, and from which it can most effectually protect, by its fire, the approaches that are pushed from its front If any circumstance, such as a hollow sheltered from the fire of the place, will permit the first parallel to be established at a distance less than 600 yards, it must, by all means, be taken advantage of.

Beyond the 3 parallels, and nearer the place is the lodgment on the crest of the glacis, which is said to *crown the covered way*. It is here that the batteries in breach are established. Next comes the *Descent of the Ditch*, which is a subterranean or covered passage from the glacis to the ditch. And last of all, approaches are made across the ditch to the foot of the breach, which are called *Passages of the Ditch*.

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The duty of the artillery will be, to establish, 1st. The batteries intended to silence the fire of the place, and thus facilitate the approaches and render them safe; 2d. The batteries in breach, to open the rampart so as to permit the troops to pass, and the counter-batteries to meet the cannon that might be brought to bear upon the troops marching to the assault over the passage of the ditch.

Such is a general view of the labours of the attack, to the minuter explanation of which we shall now proceed.

SECOND PERIOD OF THE SIEGE.

First Parallel.

Orders having been given to open the trenches, the chiefs of the several departments cause the ground to be reconnoitred in the day, both by those who are to cover the work, and those who are to execute it. They also instruct them in their several duties. Night is the proper time to open the trenches, for then the men who begin the work, are either not seen at all by the enemy, or his fire is rendered uncertain by the obscurity.

About 7 battalions, (in ordinary cases,) are ordered on this service,* who march about dusk and take their posts about 100 yards in front of the place chosen for the first parallel. These troops (*t*, *t*, *t*, pl. 7. fig. 68.) lie down on their faces, so as to be concealed from the search, or the view of the besieged. Each battalion detaches on its front, and to the right and left, small parties to observe the motions of the enemy, with orders not to fire, but

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* The troops who protect the workmen are computed at the rate of a battalion for every 4 or 500 yards, according to the force and activity of the garrison, or else they must be equal in number to two thirds of the garrison, beside some squadrons of cavalry.*

The number of labourers is estimated by allowing one for every 5 feet of parallel, or trench of communication. The first parallel has an extent of about 3,000 yards.

** The first of these rules is applicable to large fortresses requiring armies to attack and defend them, the latter to smaller works.* Tr.

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to charge with the bayonet, and take prisoners all the patroles they meet.

"The workmen do not set out until a short time after the troops have marched, in order to give them time to take their posts. Each labourer carries with him a fascine 6 feet in length, a spade and a pickaxe. They are conducted by the Engineers to the several parts of the work they are to perform, in separate troops, and by different roads, in order to prevent confusion. Each Engineer allots his workmen their places, by laying their fascines along the line of the work, and displaying them upon it. As soon as he has placed a fascine, he causes the man who brought it to lie down behind it, until he has ascertained that the whole of his line is correct. When this is done, he gives the order to begin the work, which is repeated in a low voice from one end of the line to the other. Each workman must have been beforehand directed to leave a berm between the excavation he is to make and his fascine, and to make a proper slope. The officers must not neglect to see that this is attended to, nor to preserve silence and good order; they will also incite them to diligence. The circuit of the first parallel ought to embrace all the works of the place that can act against the attack."

"It often happens, that the opening of the trenches is unknown to the besieged for some hours; nay, sometimes for the whole of the first night of the work, which is, in consequence, done without danger. Every exertion should, therefore, be made to establish the whole of the first parallel during this night, together with the communications between it and the depots of the trenches. In general, the parapets of the trench are so forward when day breaks, as to shelter the battalions of the guard, who retire behind them. The workmen are relieved at day break by others, who go on with the work."* (*Bousmard.*)

At each extremity of the parallel, and at a small distance from the points where it is cut by the prolongations of the most distant works, that can look into the approaches, either from the right or left, a crochet *c* is made about 30 yards in length, to prevent its

* Almost all that relates to the duty of the engineers, is extracted from *L'Essai de Fortification et d'Attaque et de Defence des Places*, par Mr. de Bousmard.

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being too easily turned by sorties. Its extremities are sometimes covered with a redoubt, as is represented in the second parallel. This is an indispensable precaution when the garrison is a strong one.

Each branch of the approaches is extended 8 or 10 yards beyond its intersection with the next. This gives room for the persons who may meet each other, going or returning, to give way, and protects the adjoining branch from flanking fires.

In important sieges a block-house, or bomb-proof hut, x, is often constructed behind the middle of the first parallel. In this are preserved the plans and the instruments required by the officers of engineers and artillery in their daily duty, together with the accounts of the labourers. It also serves the officer of the day to give his orders from, and receive reports.

While the construction of the batteries, of which we are going to speak, is effected, the engineers are busy with the communications between the first and second parallels.

Of Batteries.

We have seen that there are two sorts of batteries to be established during every siege, viz:

The first batteries destined to silence the fires of the fortress, to facilitate and secure the approaches. Among these are included all the batteries made from the opening of the trenches, until the taking of the covered way, although constructed at different times.

The Second Batteries, which are either *Batteries in Breach* to open the ramparts and give a passage to the troops, or *Counter-Batteries*, to counter-batter the cannon of the flanks, to silence the last fires, and ruin the defences, so that the troops marching to the attack may not be fired upon.

The first batteries will then have for their object, to dismount the cannon which bear upon the attack, by means of enfilading ricochet fires, and point blank fires, either direct or oblique; to chase the enemy from his ramparts, covered ways, &c. sweeping the faces by ricochet fires, howitzes, and bombs; and, also, to render the communication between the body of the place and the half-moons dangerous.

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These batteries may have four different positions with regard to the face to be battered.

1. So as to enfilade the face with ricochet fires.
2. To take it in reverse with ricochet fires.
3. To batter it obliquely from the front with point blank fires.
4. To batter it directly with point blank fires.

An enfilading ricochet fire is that which does the greatest injury to an enemy. It sweeps the whole length of the face where his cannon is placed, strikes the carriages on their sides, and although it may miss one piece, is sure to hit another, or to destroy some of the artillerymen; it takes the defenders of the ramparts in flank, tears up their top, and breaks the palisade. Its oblique fire, from within, strikes into the parapet and destroys it more rapidly than a direct fire could, particularly if it be pierced with embrasures. If it strike diagonally from without, it does harm to the work, and goes on to take the neighbouring flank in reverse, while those balls that strike lower, tear down the parapet opposed to them. In fine, the ricochet will hit objects sunk, or defiled, that a point blank fire cannot reach. It is evident, that it gives a very great advantage to the besieger, for four or five cannon will suffice to dismount and silence three times their number, ranged in battery along the face of a work 100 yards in length; while twice as many guns discharged point-blank, would not produce the same effect. Two pieces enfilading the covered way of the same face, will sensibly lessen the musketry fire, by forcing it to seek shelter behind the traverses. Traverses, it may be said, will preserve from the ricochet fire, or will, at any rate, lessen its effect. But these traverses must be often repaired under the fire of the enemy, and will thus occasion great loss of men, while from the space they occupy, (equal to that taken up by a gun,) they diminish by at least one third the number of cannon that may be placed in battery, on any one face.

These ricochet batteries ought to be established on a line perpendicular to the prolongation of the face to be battered; but local circumstances will sometimes prevent them from taking this position. The battery must then be placed without the prolongation, in such a way as to take the face in reverse. It must be observed, that in this position the battery is sometimes isolated from the trenches so as to be out of the reach of aid. On this account it must not

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be placed thus, unless circumstances favour it; such as a river that prevents the besieged from reaching the battery, or a parallel so far extended as to protect it.

If the preceding position cannot be taken, the battery must be placed on the other side of the prolongation, to batter the face diagonally from without; then the battery will fire point blank, like the battery No. 1.

If neither of these three positions can be taken, the battery must then be made direct, and constructed parallel to the face that is to be battered. This battery will fire point blank. The preceding position is better than the last, because, in order to attain the object of silencing the fire, the parapet must be destroyed, which is more easily done by diagonal than by direct blows; besides, the oblique position of the battery renders it less exposed to the fire of the face meant to be attacked. (*Gassendi.*)

Of the Position of the Batteries established under the protection of the First Parallel.

In the attack of a front, the approaches are carried forward, by trenches, on all the capitals at once. It being the object of the first batteries to silence the fire of all the works that act against the trenches, it may be seen at once, by inspection of the figure 68, that a battery must be constructed for that purpose, against each of the four faces of this front, as well as against the two faces of the two collateral bastions, and those of the two half-moons that play upon the batteries of the besieger, and into his trenches. This will require eight batteries either with enfilading ricochet, or point blank fires, against these eight faces.

Forty-eight pieces of heavy, or medium caliber, without counting at least half that number more of howitzers, mortars, and stone-mortars, are allowed for the attack of a single front of a hexagon, such as that represented in figure 68. The number of guns must be augmented, if more than one attack be formed. (See the chapter on Stores and Equipage.)

Upon the above principles, the batteries to be established for the attack of one front of the figure 68, are as as follows, viz.: No. 1. A battery of 5 or 6 24 pounders, at the extreme right of the first parallel, to batter the right face of the half moon 3, whose fires bear

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on the works of the attack. (I suppose that it has not been possible to establish it either perpendicularly to the prolongation of the face, and thus enfilade it with ricochet fires, nor without that line, so as to take it in reverse.) It serves, at the same time, to batter the face of the next bastion, and to take the rear in flank. There are, besides in this battery, two pieces to enfilade the covered way, in front of this face; and two 12 inch mortars, to throw shells upon the face, into the covered way, the ditch, and the next bastion.

No. 8 is a battery of 3 or 4 18 pounders, at the extreme left of the first parallel; it enfilades, with ricochet fires, the left face of the half moon 5, batters at the same time the right face of the bastion, and takes the flank in reverse. Two other pieces enfilade the covered way, and batter the bastion in the rear, and two mortars throw shells on the face, and its covered way, into the ditch, and the works in the rear. The mortars must be pointed in the direction of the ditch, between the pieces that batter the face, and those that act against the covered way. I only put 3 or 4 pieces to fire against the face of this half moon, because, as they have the advantage of the ricochet, fewer are required there than in the former case.

No. 2 is a strong battery of about 6 pieces, 24 or 18 pounders, to enfilade with ricochet fires, the right face of the bastion I, which has a strong action on the attack. It takes, at the same time, the right flank in reverse, on which the besieged will soon establish some pieces, in order to disperse his artillery when the faces become too hot for him; 2 howitzers enfilade the covered way, 3 mortars throw shells on the faces, into the ditch to interrupt the communication with the outworks, and into the bastion 1.

No. 7 is a battery of the same force, on the left, to act in the same manner against the bastion 2.

No. 3 and No. 6 are batteries of 24 and 18 pounders, that enfilade the faces of the half moon 4, and the branches of its covered way; they, at the same time, batter the flanks of the bastions, and the opposite faces. When the second parallel is completed, 2 howitzers and 3 8-inch mortars, will be placed in this battery to fire into the covered way, the ditches, and the half moon itself. I place the howitzers and mortars of these batteries in the second parallel, in order that they may fire with more accuracy, as the

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distance is less, and because it is useless to establish them, from the first, in the first parallel.

No. 4 and 5 are two batteries of 4 or 5, 18 or 12 pounders, to enfilade with the ricochet, the left face of the bastion 1, and the right face of the bastion 2; they also batter directly, the two other faces, and the flanks of the collateral bastions; and diagonally the faces of the half moon.

It is probable that the besieged will carry part of his artillery to the flanks and curtains, so as to preserve it from the destruction which awaits it, if left on the faces of the bastion, and even of the half moon. A battery must, therefore, be established at the second parallel, upon the prolongation of each flank, to batter it, and strike the curtain through the gap left by the tenail.

It may perhaps be said, that as the batteries of the first will be masked by the second parallel, it would be better to wait until it be constructed, and establish them there, so as to avoid recommencing a work so painful and dangerous. Notwithstanding this, the construction of some of the batteries of the first parallel cannot be dispensed with, because they are required to facilitate the progress of the trenches of communication, and particularly the second parallel, by combating the fire of the place. It may, however, be well to establish as few as possible, and only those that are needed to diminish the fire of the fortress, and protect the work of the trenches.

It will not be necessary to reconstruct the batteries, No. 1 and 8; and even the batteries 2 and 7 may remain if the extremities of the 2d parallel be carried no further than the points where it begins to interfere with the fire of these batteries. Thus the four batteries, (Nos. 1, 2, 7, and 8,) with enfilading and diagonal fires upon the counter approaches, may be served without interruption to the end of the siege. The mortars and howitzers of the batteries 2 and 7, may be removed to the second parallel, to make their fire more certain. Batteries for them may be made with more ease than for long guns, because they may be sunk 3 or 4 feet into the earth.

There will then remain only the batteries 3, 4, 5, and 6, which must be carried forward to the second parallel; they may, in the first instance, be made less strong, and even it may not be necessary to establish Nos. 4 and 5, in the first parallel at all.

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The ricochet batteries may be placed with effect at 600 yards from the place, but howitzers are of more certain value at 400, and mortars, although their range is very much greater than the distance between the first parallel and the place, ought, notwithstanding, to be brought into the second parallel if it be possible. Those of small caliber, especially, require this in order to make their aim more certain. The object is not, to fire upon a great surface, nor over the whole place that is attacked, but upon faces and branches of works of small extent, striking upon or near the guns. On this account, I place the howitzers and mortars of the batteries Nos. 5 and 6 in the 2d parallel only.

Batteries may be placed behind the first parallel if there are any advantageous positions for them. If, for example, commanding situations *h* are found, 4 to 600 yards in the rear, from which the shot will plunge into the works, they must be occupied by strong batteries of 24 pounders, that will do great damage, with either direct or ricochet fires, as the experience of many sieges has shown.

Some military men object to placing the batteries in the parallels, because they embarrass the manœuvres of the troops, and are, themselves, embarrassed by them. But there are no movements in the trenches, except when the troops are relieved; besides, by placing the batteries in the parallel, they are much sooner constructed than elsewhere, because they may be begun the moment the parallel is marked out, and finished as soon as it. If they be placed in front, they cannot he commenced till the night following, and this will cause a delay of 24 hours in opening the fire, require more work, and be much more dangerous to execute. Batteries in front of the parallel have the disadvantages of masking the fire of the troops, and impeding the manœuvres necessary to meet and repulse sorties.

The position of batteries should be such that their action may be the greatest, and the inconveniences they produce the fewest; so that they may either be put in the parallel, before it, or behind it, as appears most advantageous. In the second case, trenches of communication are made to the parallel; and in the third, ziz zags, as in batteries, 1, 2, 3, &c. (At the siege of Dantzic, in 1807, almost all the batteries were made in the parallels.)

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Batteries in front of the parallel are usually distant from it 24 yards.

Construction of Batteries.

At the break of the day that follows the opening of the trenches, the artillery officers, who are charged with constructing a battery, mark upon the parallel with pickets, placed on its two sides, the prolongations of the faces of the works to be enfiladed; and also the prolongation of the covered way. If the line of the points of the palisades cannot be distinctly seen, it may be found by estimating the breadth of the ditch and of the covered way.

The position of the battery being thus determined, it is traced and constructed as directed in the first volume.

If the batteries are established in the parallels, care must be taken not to place them too low, but rather to raise them when necessary, so as to see the object distinctly when they fire point blank, and to avoid disturbing the work of the trenches that may pass in the line of their fire.

Whenever the situation of the object, with relation to the position of the battery will permit it to be sunk to the *genouilliere*, it must be taken advantage of. By this will be obtained the double advantage of a more solid and a more easy construction.

The erection of a battery, and arming it, will require together about 36 hours. But they may generally open their fire towards the close of the second day, if begun early in the morning of the first. Time will thus be allowed to observe their effect before night fall, and to ascertain by a few rounds the proper charge and elevation for the pieces, particularly those that fire the ricochet. These being known, the proper steps may be taken to make the fire as efficacious by night as by day; to do this, the direction of the piece is fixed by slats nailed upon the platform along the track of its wheels, or by marks upon the knocker, and also on the platform at the place where the trail of the carriage is to lie. The degrees of elevation are fixed by a mark upon, or a nail driven into, the pointing wedge.

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Of the Service of Batteries.

A Battery must not be opened the instant its cannon are mounted, because this would draw upon it the whole undivided fire of the place, that would infallibly destroy it; it must remain silent, on the contrary, until the whole of the batteries are finished, they should then be unmasked at the same instant, and the enemy attacked from every point, in front, in flank, and in rear, can no longer act with the same precision, and is obliged to scatter his fire, which is in that way much less fatal to the besiegers.

The following rules, for the service of batteries, are laid down by *Dupuget*, and other chiefs of the art.

"Observe carefully the effect of the fire: and make the matrosses remark it also, in order that they may amend it if faulty, or continue it if correct."

"In the day time as much fire as possible ought to be united on those batteries of the enemy which it is most essential to dismount, the others are merely to be harrassed, from time to time, with a few ricochets."

"At night all the batteries should fire ricochets, as much to harass the besieged in the repairs he must make in his own batteries, as to prevent him from erecting traverses, that might in the end impede the action of your ricochets.

"More care must be devoted to the service of the mortars than to that of the guns, for it is less easy to fire them with accuracy."

"Shells should be directed, in preference, to the parts of the works that are least exposed to the ricochets, such are the low flanks, the tenails, the retrenchments of the places of arms, and of the covered way, the caponniers, sluices, &c.

The quantity of powder in the shells must be regulated by the effect they are intended to produce. If they are to overturn and destroy buildings, or produce the effect of a mine, they must be filled; but against men, and feeble obstacles, the charge may be much less.

"The batteries must be repaired as fast as they are injured, particularly those of the guns. The neglect of a trifling repair, that if attended to might have been done in a quarter of an hour, may cause the silence of their fire for whole days.

"The object of the fire of each battery should be given in

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writing, and the commander should never alter it without authentic orders from the proper authority. If every officer had the power of directing the service of his battery according to his own views, they would never further the main design."

A fire should never be directed against public or private edifices, without express orders from the highest authority. The private soldier loves wanton destruction, but the officer, who should unite humanity to bravery, ought to set his face against it, unless he have orders from the general of the army, who may have powerful motives for giving them. Among these legitimate motives, are the wish to burn large collections of stores that would be of no value to him, but useful to the enemy; the hope of inducing a large population to revolt against a weak garrison, and compel it to surrender the place, &c.

Continuance of the work of the Trenches.

We have already said, that the communications between the first and second parallel, are carried on during the construction of the batteries. It is to be expected that the enemy will direct a most lively fire against this work, and will even attempt to interrupt it by sorties. To prevent the flight of the workmen, they are supported by detachments of grenadiers who lie on their faces, in front, and on the flanks of the work. These do not rise until the proper time for opposing the sortie, of which they are advised by small posts advanced for the purpose. If the sortie is too strong to be repulsed by these detachments, they retire along with the labourers into the second parrallel, endeavouring, at the same time, to draw on the enemy, until the cavalry, placed on the extremity of each parallel, advance to cut him off from the place. The detachments will then attack him in front, while the infantry posted in the parallel, marches forward to take him in flank. (See fig. 68, where this movement is shown as taking place on the right of the first parallel.)

The cavalry *v* is sheltered by some natural cover, or by an epaulment *e* constructed for that purpose, at the same time as the parallel. This epaulment is 8 feet high, and 12 feet wide at top. The infantry *i* is drawn up at the extremity of the parallel.

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The besieger cannot have reached the position of the second parallel with his approaches, in the time required for the construction of his batteries. Neither ought he to undertake its erection until the fire of the batteries has begun to produce a sensible effect. (*Bousmard.*)

The Second Parallel.

This parallel is established about 300 yards from the salient angles of the covered way, choosing the most advantageous position for it, and adapting it to the ground. It envelops the salient angles of the Fortress in the same way as the first parallel. It ought not, however, to be so far extended as to mask the batteries established at the extremity of the first parallel, to enfilade the more remote faces. If it has not been possible to establish these batteries in the first parallel, the second ought to envelop the remote salients, and receive these batteries.

The second parallel is traced and constructed nearly in the same manner as the first, with this exception, that as musketry can produce its full effect at the distance it stands at, gabions are used to draw it on the ground; this is called tracing by the *flying sap*. These gabions, even when empty, will stop the course of a musket bullet. They are placed one beside the other, and when filled they are bound together and supported by fascines laid over them lengthwise. (Profile fig. 72.)

Detachments of grenadiers are placed at some distance in front, to protect the workmen, and repulse sorties, besides some battalions in the communications that are pushed nearest to the place.

As soon as the parallel is in a condition to receive the troops that have covered the work, they retire into it by day, together with those that have supported them. None are left, in the first parallel, except at the extremities, where they extend beyond the second. A force is placed there to preserve the second from being turned by sorties. It is, moreover, defended from them, when there is a chance of their being strong, by redoubts, *r*, *r*, constructed at its extremities, and mounted with field artillery. The extreme communications *k k*, from the first to the second parallel, are in a straight line, with a banquet to receive troops. (fig. 80. pl. 9.

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is the profile of these redoubts, the epaulments not exposed to the fire of the place, are only half the thickness, and the glacis on their counterscarp, is suppressed. Their covering line has usually an extent of 80 yards.)

As soon as the second parallel is in a state of forwardness, the batteries, which could not be constructed in the first parallel, are made in it, and those that are masked moved forwards into it.

Half Place of Arms.

As soon as the second parallel is finished, approaches are pushed from it upon all the capitals without loss of time. This labour is supported by detachments of grenadiers posted in every part of the second parallel within reach, and ready to march over the parapet to cover the workmen.

These approaches are pushed forward to the distance of 150 yards from the salient angles; this is the place of the demi-places of arms, or half parallels, *p*, *p*, *p*, *p*, that spread to the right and left of each capital, as far as is necessary to envelop the prolongations of the branches of the covered way, that form the salient angle, towards which the approaches are making. They afford a support, necessary to the progress of the approaches, in consequence of the distance they are now from the first parallel; they serve for the establishment of batteries of mortars and howitzers, to sweep the covered way, destroy its palisades, and prepare for the attack by storm; they may also enfilade the flanks of the bastions. The construction of these batteries may be commenced in the morning, and finished, as it is not laborious, within 24 hours, so that they may open their fire early the next day.

If they have produced a sensible effect by the following night, the approaches may be continued forward. At this distance, however, the fire of the enemy has become too deadly to permit, the placing of the gabions without some shelter. It here becomes necessary, in consequence, (if circumstances have not required it before,) to give up this rapid mode, and to proceed by the *sap proper*, in the following manner.

"A sapper armed with a cuirass and helmet, setting out from the termination of the flying sap, covers himself from the fire of the

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place, with a large stuffed gabion.* (*g*, fig. 76. pl. 8.) that he rolls before him, and places at will, by means of a sort of fork. He then places a gabion, which he fills quickly with earth, taken a foot in rear of the berm, and lodges in the space left on the inside; between this gabion and the last of the former work, two sand bags are placed on end, one on the other, or else a sap faggot †

Being thus covered, he enlarges his trench to a square of 18 inches, which allows him to enter it on his knees, and place a second gabion in front of the first, still pushing the stuffed gabion before him. When he has placed the third gabion in this manner, the second sapper, (who has handed forward to the first the gabions, sandbags, &c.) also enters the sap, and commences his work by covering the three gabions with three fascines; he then enlarges the sap, both in width and depth, to the extent of 6 inches more. When he has constructed a length of 4 feet in this way, he is followed by a third sapper, who increases the sap to the breadth and depth of $2\frac{1}{2}$ feet; and the third is, in his turn, followed by a fourth, who gives it a dimension of three feet each way. The sap has, by this time, acquired sufficient depth and thickness of parapet to permit ordinary workmen, without defensive arms, to enter and increase it to the usual size of the trenches. It is, henceforward, considered as a part of them, and no longer called the sap, which name is limited to the 16 feet occupied by the 4 sappers. These are relieved every hour in their laborious and dangerous business, by other sappers, and in the course of their tour of duty, each passes in his turn to the head of the sap. In this manner, the approaches may advance 160 yards in 24 hours. The execution of the sap is protected by the fire of troops placed in the half places of arms, who return the musketry fires of the place through loop-holes, formed of three sand bags. (pl. 8. fig. 74.)

Detachments of grenadiers take their posts in the communica-

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* This gabion is very large, say 6 feet long, and 3 feet in diameter; it is stuffed with fascines, or small twigs, so as to make it musket proof.

† A sand bag is a small sack of coarse bagging, filled with earth, and tied at the end with twine; in this state, it is 18 to 20 inches long, and 8 or 9 inches in diameter, and will stop a musket ball.

A sap faggot is part of a saucisson, 2 1-2 feet long, and having a picket through its middle, that may be driven into the ground to keep the faggot upright.

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tions as soon as they are finished, and remain in readiness to sally out and repulse every sortie that might be planned, to trouble the progess of the sap. (*Bousmard*, vol. 4.)

When the zigzag approaches on the capitals are within 60 or 70 yards of the covered way, or at the foot of the glacis, they have reached the position of the 3d parallel.

THIRD PERIOD OF THE ATTACK.

Third Parallel.

The third parallel may be easily established by the sap proper, in 24 hours. Two saps set off from the approaches, to the right and left, upon each of the three capitals of the front attacked, and a single sap from the exterior capitals. This third parallel, (pl. 8.) furnishes places for new batteries that will overwhelm the defences of the besieged with such a quantity of projectiles as to prevent him from making much use of his musketry, and will overturn all the batteries he has still preserved in his works.

They are armed with howitzers to enfilade the flanks and faces of the bastions, (in the latter case they take the flanks in reverse,) the faces of the half moon, and the branches of the covered way; with mortars to scour the interior of these works, and of the curtain; with stone mortars, whose most valuable service is to disquiet the re-entering places of arms of the covered way, that, by their situation, are protected from the ricochet.

When the distance is too great for the service of stone mortars, as may happen if the half-moons are very salient, grenades are thrown.

These batteries are placed to the right and left of the three capitals, and nearly perpendicular to the prolongations of the faces of the half-moon, of the bastion, and of its flanks.

" This third parallel encloses the besieged in such a way that he can longer sally from the covered way of the front of attack, without sustaining a close fire; enables the besieger to attack the covered way by storm whenever he pleases, by giving him a field whence the troops may march, in a few moments, to the covered way. Where it is intended that this place of arms shall be used for this purpose, care is taken that steps *g* be formed with fascines

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to the right and left of each capital, of sufficient width to permit the passage of the front of a company of grenadiers." (*Bousmard*, vol. 1.)

As soon as the third parallel is equipped with its batteries, the approaches may be carried forward from it to attack the covered way, in order to crown it, or form a lodgment on the crest of the glacis, and then establish batteries in breach.

Crowning the Covered Way.

The crowning of the covered way, and the establishment of batteries in breach, and counter-batteries upon it, is the most delicate and most bloody operation of a whole siege.

There are two modes of forming a lodgment in the covered way. 1. By attacking it by storm, and forming the lodgment with the flying sap. 2. By approaching over the glacis, inch by inch, and crowning it with the sap proper. This second method is evidently the least dangerous; but as the first saves time, it is usual to employ it when any circumstance compels the besieger to press the siege. If, for instance, it be feared that the place will be relieved, or if it be certain, from want of courage in the garrison, or the bad state of the covered way, that the attempt will neither fail nor be too bloody.

If, on the contrary, the besieged has good reducts in his places of arms; if the covered way is defended by a double palisade, or has barriers; or if a lively fire of musketry from the ramparts is to be feared, or from guns that may have been preserved by means of traverses; this operation, which might cost many lives, and after all fail, is not to be attempted. The approaches must then be made foot by foot, and the lodgment by the sap proper.

The following is an account of these two several methods. (*Bousmard*, vol. 1.)

"Attack by Storm. When the third parallel is completed, armed with all its batteries, and surmounted by sand bags, forming loop-holes, from which a fire of musketry may proceed, superior to that of the works of the front attacked; when it is furnished with the steps we have just described, there must be collected in it,

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" 1. The chosen troops selected for the storming party.

" 2. The workmen who are to form the lodgment.

" 3. The gabions, fascines, and tools required for this work.

" Every thing being thus prepared, the enterprize will be begun by a fire from all the batteries upon the defences, in order to destroy or disable every thing yet left that can prevent success. At last, at night-fall, while there is yet light enough to see to act with order, the storming party will march out rapidly, on a given signal, from the parallel, and proceed to all the salient angles of the covered way, and to the sides of the defiles of the traverses, whence, by a close fire, they will chase the enemy from the covered way. The troops will then cautiously enter it through the breaches the artillery has probably already made in the palisade, or by others cut by the sappers with the axe. They will shelter themselves by the traverses, in the sally-ports, and behind the gabions of the lodgment that are the soonest filled, whence they will keep up a fire on every thing that they see move.

" As soon as this attack shall have succeeded, the labourers will march to the salient angles of the covered way, and crown them with a flying sap of sufficient length to prevent the besieged from returning to these parts of the fortification. Between the traverses of the salient places of arms, and in front of the re-entering places of arms as far as their barriers, will probably be sufficient. If it should be afterwards thought proper to crown either the whole or part of the remainder of the covered way, it will be soon enough to do it when the new batteries shall have opened their fire. Traverses must be made in these lodgments to shelter the troops from the fire of the collateral works. (The left side of the work (pl. 8.) shows the covered way, partially crowned in this way, while the right shows it entirely crowned.) This lodgment is drawn nearly parallel to the crest of the covered way, and at a distance of 15 or 18 feet from it."

" At the same time that the first workmen crown the covered way, others are employed in making communications between the lodgment and the third parallel. These communications are no longer traced in zigzags, for the branches of these would be subject to enfilade. Instead of this the approaches are made in a straight line along the capital of the angles to be crowned, with a

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parapet on each side, and traverses or tambours to protect the troops from fires in the direction of the capital.

"Of the Attack by gradual approaches. In order to take the covered way by gradual approaches, and crown it with the sap proper, trenches are opened from the third parallel, not directly upon the capitals, but 24 or 30 yards to the right and left of them. These are carried forward in a circular shape, until they meet each other, and form, by their union, a curved surface of about 20 yards in depth, defiled by means of its figure, from the fire of the place. These curves also produce cross fires at their re-entering angles, and afford shelter to the troops who support the workmen. From the middle of each curve a double trench is formed, directly towards the capital. That is to say, two saps are opened parallel to each other, and the earth thrown to the right and left, leaves at last a single trench 12 feet wide, with a parapet on each side. As soon as it is found that the bottom of this trench can be seen from the place, over the gabion that is rolled at the head of the sap, a traverse is made. This traverse is a mass of the natural ground left by the sap that passes on each side of it, and surmounted by gabions.

"When their trenches have been carried within 30 yards of the salient angles of the crest of the covered way, at *s*, a distance about equal to that over which a grenade may be thrown, the two saps are separated, and turning directly from each other, describe an arc of a circle round the salient angle of the covered way, until they cut the prolongation of the crests of the two branches that form the salient angle. They are thence prolonged, perpendicularly to the nearest branch, (or if the angle be obtuse, parallelly to the other branch, in order to prevent them from approaching the place too closely,) for a distance equal to the width of the covered way, they then terminate in returns that defile them from the fire of the collateral works, and form the half places of arms *c v*, *c v*.

"The portions that are perpendicular to the covered way, are intended to enfilade it in the rear of its palisade, and thus compel the besieged to abandon it. For this purpose they are raised, by means of several stages of gabions, to such a height, that a plunging fire may be made from their parapet into the place of

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arms and the adjoining terraplain ; and thus the farther occupation of them is rendered impracticable.

"The parts thus raised to plunge into the covered way, are called *Trench Cavaliers.* Steps are made within them to pass from the bottom of the trench to the banquet, and the top is furnished, with sand bags arranged like loop holes. (See in fig. 75, the profile of the trench cavalier along the line *c b.*) Sometimes, in order to avoid this long and painful labour, these half places of arms are furnished with stone mortars to sweep the covered way, and clear it of the besieged. Howitzers are also placed in it to ruin the traverses and tambours of timber.

"These cavaliers are sometimes united together by a trench, *q*, *q*, which is, in fact, a fourth parallel. Care is taken to round this between the two cavaliers, so as to make it approach the salient angles of the re-entering places of arms as much as possible. On this, batteries of mortars and stone mortars are placed to fire into the places of arms, the half-moon, and reducts. A fourth parallel is made, when the third is at too great a distance from the re-entering angles in consequence of the figure of the fortress. If, however, in consequence of the obstinacy of the besieged in holding possession of the places of arms, it is found necessary to approach nearer than can be done in the third parallel, it will be better to construct trench cavaliers of a circular figure, as *l l* opposite to these places of arms, leaving an interval between them and the trench cavaliers of the salient angle of the covered way in front of the half-moon, that will permit the action of batteries upon the faces of the half-moon. If this interval were not left, the fire of the batteries might be impeded or masked by the elevation of a fourth parallel on the slope of the glacis, and thus the besieger would be compelled to transport the batteries of the third parallel into the fourth ; this would lengthen the siege at least two days, and afford a respite to the garrison. (*Bousmard*, Vol. I.)

Double and direct saps are carried forward upon the capitals ; under the protection of the fire from the trench cavaliers, or the stone mortars established in the half places of arms, together with the fires of the works in the rear, until they come within 20 feet of the crest of the glacis. At this place the saps divide to the right and left, proceeding parallel to the crest of the glacis, which they soon crown to an extent sufficient for the establishment of

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batteries in breach, and counter-batteries that are then erected without loss of time.

Of the Batteries in Breach and Counter-Batteries.

As soon as the labours of the crowning lodgment are finished opposite the bastions and half-moon, batteries in breach and counter-batteries are established.

Batteries in breach, whose object is the destruction of the scarps of the half-moon and bastions, and thus to open a passage into the body of the place, ought to be established perpendicularly to the revetment they are to destroy; they ought, besides, to be so placed as to open the breach low enough to make it accessible by the troops. In consequence, the batteries *b b*, that batter the bastion, are established in the space between the first and second traverses of the covered way. They may also be placed on the branch of the re-entering place of arms that faces the bastion. Those which batter the half-moon are usually placed against one of the faces, between the first and second traverses of its covered way. It sometimes happens that batteries against the half-moon are placed on the faces of the salient places of arms of its covered way only. These are both batteries in breach against the flanked angle of the work, and counter-batteries to those parts of the bastion faces which lie opposite the opening of the ditch and the covered way of each face of the half-moon, and serve it as flanks. They may at the same time make accessible breaches in the bastion faces. In spite of this double, nay, triple advantage, I should prefer the first-named situation, that is to say, between the first and second traverses, because the fire from the salient angle of the covered way is too oblique to make a breach with ease. Besides, a breach is more easily made in the reduct from the first position, as an examination of the figure of the half-moon, No. 4. will show.

Counter-batteries are intended to encounter the flanking fires of the body of the place, that sweep the ditches, and render its passage difficult and bloody. They also meet the fire of the collateral flanks that would otherwise prevent the crowning of the covered way. The counter-batteries of the flanks of the bastions are placed on the faces of the salient places of arms, as *c b*, *c b*, whe-

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ther these flanks belong to the bastions of the front attacked, or to the collateral ones that have an action on the covered way.

These counter-batteries begin with attacking the cannon in front of them, and when they have silenced or dismounted it, they go on to ruin the parapet behind which it is placed, and thus prevent its re-appearance. To do this, they have only to batter in breach, the revetment that upholds the parapet, as low as possible. As soon as this revetment has fallen, and with it almost all the thickness of the parapet, there is no longer any difficulty in battering down the rest. The batteries in the salient angle of the covered way of the half-moon, may also, in the same manner, destroy the parapet of the faces of the bastion; this should be done as near the shoulder as possible, so as to lay open the flanks to enfilading and reverse fires, from the crown of the covered way, or from the third parallel, in either of which, batteries of howitzers may be established for that purpose.

Batteries in breach and counter-batteries, are usually established in the sap of the crown of the covered way, and as this is often no more than 18 feet from the crest of the glacis, the epaulment of the battery cannot be more than 12 or 15 feet thick at top. If the sap were more distant, the epaulment might be made thicker, provided the foot of the rampart could be seen from it. If, on the contrary, the rampart cannot be seen as low as 6 feet from its foot, from the lodgment on the crest of the glacis, either by reason of the breadth of the covered way, or the depth of the ditch, it will become necessary to descend into the covered way, and make a lodgment for the construction of the battery, at a distance of not less than 20 feet from the counterscarp. This construction is both longer and more dangerous than the other, and to do it, a sap must be extended to it from the crown. (*Bousmard.*)

In both cases, the battery is constructed from within, taking advantage of the sap that crowns the covered way. Into this the battery may be sunk to the *genouilliere*, which will prevent the necessity of raising the bottom of the sap for the purpose of establishing it. The earth removed from the sap, may be thrown upon those parts of the parapet that are to serve as epaulments, and care must be taken to remove the gabions of the sap that

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happen to be placed at the opening of the embrasures, as they might hinder their being cleared out.

The traverses that must be made to guard against flanking and reverse fires, will lessen the space the battery in the sap of the lodgment ought to occupy. It should not be of fewer than four pieces of cannon, and therefore if the space be narrow, no more than 12 or 15 feet can be allowed to each. Care must be taken that no embrasure is made opposite to a traverse. The 24 pounders used in these batteries are brought from such of the first batteries as have fulfilled their objects.

As the epaulment is not more than 12 or 15 feet thick, the outer opening of the embrasures need not be more than 6 or 7 feet. The batteries in breach, require shutters to their embrasures, more than any others, to shelter the gunners from the musketry of the place. In them should also be placed expert marksmen, to repress, by musketry, the infantry fires of the place, which their near proximity now renders extremely dangerous.

The construction of these batteries should be pressed with the utmost activity, for if the garrison does its duty, the work will be exposed to a most violent fire of cannon, mortars, stone mortars, and musketry. Mines are also to be feared, but we shall speak of them hereafter in the journal of the attack and defence.

In order to open an easy passage for the troops who are to make the assault, the batteries in breach must not fire at random. They will begin by marking out with their balls, the breach that is to be made; this is done, by cutting into the revetment three deep gashes, one of which is 6 feet above the level of the ditch, (if dry,) or at the level of the water, (if it be wet,) and horizontal, the others vertical, and reaching from the extremities of the first to the top of the revetment. This being done, they will continue to fire into these three gashes in order to deepen them, and thus detach the part that is to be overthrown from the rest of the revetment. If the revetment still resists the pressure of the earth within it, a few discharges of all the pieces at once, producing a violent shock, will complete its total overthrow. When this takes place, nothing will remain but to batter down parts of the buttresses that may remain standing, and to clear away the ruins of the parapet.

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As soon as the wall is down and the parapet destroyed, the breach is as perfect as it can be made. To continue the fire would not render the slope more easy. If the breach is impracticable on account of the horizontal gash having been made too high, it is no longer in the power of the cannon to improve it.

A breach is usually made from 24 to 30 yards long, and it may be effected by four pieces of cannon in four or five days.

In order to cut the masonry, the balls must have the greatest initial velocity that can be given them, say 15 or 1600 feet per second; but for shaking the wall and causing its fall, a less velocity, say 11 or 1200 feet, is better. (*Gassendi.*)

Of the Descent of the Ditch.

While the batteries in breach and counter-batteries are established and in action, along with those of the third or fourth parallels, *Descents* are made into the ditches, that enter them at their bottom when dry, and at the water's edge when wet.

The descent of the ditch is a passage, either subterranean or open, that leads from some part of the glacis to the ditch, passing through the mass of the covered way. See the points *d*, *d*, *d*, on the plans, and fig. 79, pl. 9.

"The descent of the ditch is usually commenced behind the covered way, and in rear of one of the traverses, so as to be sheltered by it from the fire of the place. It is begun at some distance, in order that the slope may not be more than six inches to each yard. If it were greater, the descent must be by steps, which is inconvenient. When it reaches the point where it is to enter the ditch, the counterscarp is pierced for the purpose.

"All those parts of the descent of the ditch that are open to the sky, must be sheltered from stones, grenades, and the fireworks of the enemy, by hurdles and fascines, covered with sand bags and sods, the whole of which is supported by strong frames, that are called *blinds*. Fig. 78. pl. 9. shows the simple mechanism of their arrangement.

"When the ditch is deep, the removal of earth would be enormous if it were necessary to make the descent open at top. In this case, after it is made open as far as possible, it is then carried

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beneath the ground like the gallery of a mine, with a width of five feet, and a height of not less than six.

"Instead of making a descent to the ditch, the counterscarp is sometimes overturned by small mines opposite to the breach, (as is done in the case of the half-moon on the plan,) and a sap carried down over the rubbish produced by these explosions, to the bottom of the ditch, the passage of which is then made. In ordinary cases, the advantages and disadvantages of this method, are nearly equal; but it alone can be used when a countermined gallery extends along the counterscarp." (*Bousmard.*)

Of the Passage of the Ditch.

By the term *Passage of the Ditch*, are known, the works erected across it to connect the opening in the counterscarp with the breach, so that the assault may be given with as great a chance of success, and the least possible loss. (Fig. 79. and the profile on the line *a b*.)

"As soon as an opening is made in the counterscarp large enough to permit the passage of small articles, a sapper places himself beside it, and endeavours to begin an epaulment to meet the fire of the flank that defends the ditch. This he does by throwing such things as are handed to him into the ditch, these consist principally of fascines and sand bags. As soon as the epaulment is large enough to afford a shelter, the opening in the counterscarp is enlarged to the same size as the descent of the ditch, and a passage *p*, is commenced behind the epaulment, by the sap proper, if the ditch be dry and have earth at bottom; by raising an epaulment *e*, of materials passed down through the descent of the ditch, if the bottom be of rock; or if it be full of stagnant water, by filling it up and making a dyke of beds of fascines and earth, held together by small pickets, on the side of which an epaulment is erected with fascines, sand bags, and sacks of wool. The last material is enclosed in the hide of newly slain beasts, in order to prevent fire.

"If the ditch is of running water, or if it may be inundated by the play of sluices, the passage must be a bridge of fascines that will float. This is kept in its place by small anchors cast up the stream.

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The cables of these anchors allow the bridge to rise and fall with the water. Fig. 77. pl. 9. represents the profile of the breadth of the bridge, and shows the epaulment.

"In order to render this floating bridge fit to carry a heavy weight, for example, a column of infantry, and even heavy guns if necessary, five or six ranges of timber, of from four to fix inches square, are laid upon the lower beds of the fascines that form the bridge, in the direction of its length, these are pierced at distances of four feet by bolts of wood three feet in length, entering equally deep into the beds of fascines above and below the timbers. To these timbers are fastened the ends of the cables attached to the anchors." (*Bousmard.*)

It has been proposed, by some engineers, to build a raft, surmounted by an epaulment, along the edge of the counterscarp, and then wheel it round to its place. This method appears to be both difficult and dangerous.

In whatever manner the bridge is constructed, care must be taken to fix its ends firmly, as well to the counterscarp as to the breach.

Figure 79 shows this passage, made near the flanked angle of the bastion 1, and reaching from the entrance of the blinded passage to the top of a breach.

If mines be employed instead of cannon, to make a breach, it is not the less necessary to perform all these operations of the descent and passage of the ditch, as well for the purpose of forming mines, as for crossing the ditch to the assault, out of the reach of flanking fires.

Of the Assault.

By the assault, is meant the operation by which the besieger possesses himself of some part of a fortress which he enters through the breach. If there be no reduct in the half moon, nor in the re-entering places of arms, the assault is made on the body of the place as soon as the breaches are practicable, and the passages of the ditch finished. To prepare for it, the fire of all the batteries is directed upon the top of the breach, as well for the purpose of smoothing it, as for that of preventing the besieged from appearing there; some sappers endeavour to recon-

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noitre the ground over which the storming party is to pass, at night-fall, in order to ascertain whether there be a retrenchment behind the breach, or not.

"If there be no retrenchment, the besieged rarely awaits the assault, but surrenders as soon as the breaches are practicable. In either case, however, the besieger should press on this work, so as to give the assault before the besieged thinks him ready for it.

"In order to divide the forces of the besieged, and increase the chances of success, all the breaches should be attacked at once. To scour the threatened works, the curtains and avenues through which the garrison must march to the defence of the breach, a fire must be opened from all the batteries until the moment of assault, and the counter batteries of the flanks must even continue their fire over the head of the assailants, until they are established in force on the top of the breach.

"If it is found that there is no inner intrenchment, the assault of the body of the place must be given with as many troops as can possibly act at once without confusion. These must be assembled at night, in the trenches, immediately behind the descents of the ditch, and as secretly as possible ; part of them must then descend silently, and place themselves along the epaulment until it be filled. At a given signal, the division which is to march at the head of the column, is formed at the foot of the breach ; it mounts rapidly to the top, while a second is quickly formed on the ground it has left. This is continued without interruption until all the troops who are to enter at the same breach, have passed into the place. The first troops march along the ramparts to the principal posts, particularly the gates, which are seized and thrown open to the cavalry.

"The troops that storm the half-moon ought to charge its guard with all possible spirit, and even follow it into the caponnier in hopes of entering with it into the body of the place. If the ditch be full of water, this last attempt cannot be made, but the assault of the half-moon being made at the same time as that of the bastions, will hinder its defenders from firing in reverse upon the breaches of the body of the place.

"If retrenchments have been found behind the breaches of the bastions, as is shown, (fig. 73.) the assault must be given by only a small body of troops, well supported ; this will be sufficient to

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dislodge the feeble detachment the enemy will trust outside of his retrenchment, and protect the establishment of a lodgment on the breach. From this lodgment, a sap is carried to the counterscarp of the retrenchment, and a lodgment made. (see bastion, fig. 1.) If the retrenchment is faced with masonry, a breach must be made in it, either by cannon or by means of mines. The last is to be preferred, as it will obviate the difficulty of carrying heavy cannon over the breach to the top of the rampart. If the retrenchment is of earth, and fraised, it will be sufficient to bring forward some light guns, (howitzers in preference,) to destroy the fraise, or if it is not flanked, it may be cut with the axe, and the work carried immediately. Before this can be done, the lodgments on the breach of the body of the place, and on the counterscarp of the retrenchment, must be furnished with mortars to throw grenades, and stone mortars, that are easy to transport. These will repress the fire of the retrenchment, that, without such precautions, would be too destructive."* (*Bousmard.*)

Thus, in case the half-moons and re-entering places of arms are without reducts the 19th day after the opening of the trenches, will see the place either taken by assault or lodgments made on the top of its breaches. It will then have no other resource than retrenchments constructed during the course of the siege. These, however, will increase the term of resistance six days, and even more, if the retrenchment is well made, and the defence well conducted. But if the half moon, and the places of arms, have reducts, as shown in fig. 73. pl. 8. the defence may be prolonged at least seven days. For the flanks of the reduct of the half-moon take the breaches in reverse, and the assault of the body of the place cannot be attempted until this reduct is taken. Neither can the passage of the great ditch be undertaken as long as the enemy possesses the half-moon, and the reduct of the re-entering place of arms. It becomes indispensable, therefore, to make a breach in the half moon, and take it by assault; the breach is, then, immediately crowned with a lodgment of gabions, to prevent the besieged from venturing into the salient part of the half-moon. Approaches by sap are made along the parapets, towards the sections, and shafts sunk in the lodgment on the breach, for mines intended to overthrow the counterscarp, and make a large opening through which batteries established along the faces may batter the reduct in

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breach. If the faces of the half-moon are wide, the breach batteries may be established upon them, as is shown in the half-moon No. 3. But if they have no more than 14 yards in thickness, like the half-moon No. 4, there would not be room for a sufficient parapet in front of the pieces, and to allow for their recoil; and these batteries would be seen in reverse from the faces of the bastions, at such an angle that no traverses would protect from their fire. For these reasons, the breach in the reduct must be made by the batteries in the crest of the covered way, or the scarp blown up by mines as soon as the passage of its ditch is completed. (The half-moon, No. 4, shows a breach in the salient angle, and one in the middle of the face, along with the destruction of the counterscarp, by means of mines.) When the lodgment is made upon the half-moon, batteries of stone mortars are established there, to act against the reduct, and the sections. Zigzag approaches may also be made in the ditches of the half-moon opening into the great ditch opposite to breaches made in the bastions at the salient angle of the covered way. These breaches are made to prevent the delay that arises from postponing the establishment of batteries in breach against the flanked angle, until the reduct of the re-entering places of arms, and the half-moon itself, are taken, before which time they cannot be placed upon the glacis opposite the faces of the bastions, as is shown at *p p*. Batteries are sometimes established in the reduct of the re-entering place of arms, to increase the breach made through the chasm of the ditch of the half-moon; they also counter-batter cannon placed on the curtain.

The counterscarp in rear of the faces of the half-moon having been blown up, the passage of the ditch of the reduct is made; the assault is given through the breach made by mines, or the fire of cannon; and the summit of the breach crowned with a lodgment, on which are established batteries of small and stone mortars, to play upon the interior of the retrenchment, the besieged will probably have made during the siege. He will not neglect to do this, as he will thereby preserve the flanks that take the breaches in reverse, and compel the besieger to take the retrenchment. In order to do this, the besieger will carry forward, from his lodgment, two saps along the faces of the reduct, and within the thickness of its parapet. As soon as the fire from this sap shall have compelled the besieged to quit the sections of the half-moon, the

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besieger will take possession of them, and push his sap along the rest of its face, to compel the besieged to abandon the reduct of the re-entering place of arms, that is immediately beneath. The counterscarp of the retrenchment of the reduct of the half-moon, is crowned by sap, and a few light pieces, or howitzers, placed on it to destroy the palisade. As soon as the retrenchment is taken, cannon are placed on it to counter-batter that of the curtains, and favour the passage of the ditch. Lodgments are made in the abandoned reduct of the place of arms, either by entering it at the postern towards the half-moon, which is broken into by the hatchet, or by throwing a bridge over its ditch. When all this has been done, the epaulments of the passages of the ditch of the body of the place, may be constructed, either at the extremity of the ditch of the half-moon, if the breach have been made through it, or at the salient angle of the bastion, if the breach have been made by batteries in the lodgment on the crest of its glacis. (Both of these methods may be seen at the bastion No. 1.) This is the time for establishing batteries in the reduct of the re-entering places of arms, if they be thought necessary for the reasons above mentioned. A continual fire is kept up from the batteries in breach, the counter-batteries, &c. and from those within the reduct of the half-moon, (from the time they are finished,) to protect the construction of the epaulments of the passage of the ditch. (*Bousmard.*)

At last, the attack is made on the body of the place, either for the purpose of taking it, or of making lodgments on the top of the breaches. Which of these is done will depend, as in the former case, on the circumstance of there being retrenchments or not. If there is a retrenchment behind the breach, approaches are made by sap, to its counterscarp, upon which batteries are established, or mines opened. (See Bastion No. 1. fig. 73.) The bastion No. 2, shows a second retrenchment in rear of the first, where a third assault may be sustained, or a capitulation made after the first is taken.

We shall give a journal of the attack and defence in the sequel, and show day by day the progress of both of them; of this we are about to treat in the next chapter.

The attack of a crown work, or horn work, is conducted in the same way as that of the front of a fortress. Arrows and other small works in front of the glacis are enfiladed with the ricochet, and bombarded.

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NOTE.—In places taken by the fire of artillery, the bells of the churches were formerly considered as belonging, in the French service, to the *Grand Master of the Artillery*, and the inhabitants were compelled to ransom them. This custom, which had fallen into disuse ever since the suppression of that office, was re-established in 1807, by an Imperial Decree. At the siege of Dantzic, by the French, the bells were given to the Artillery, and ransomed by the city.

The division of this booty was made as follows, viz.

To a Matross,	1 share.
Corporal,	1 1-2
Sergeant,	2
Sergeant Major,	8
Lieutenant,	24
Captain,	48
Major,	96
Colonel	160
Brigadier-General,	320

The General of Division who commands the Artillery, ought to have 960 parts. The sappers share with the Artillery; the train and assistants, each receive half as much as the others.

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OF THE DEFENCE OF FORTRESSES.

THREE periods are distinguished in the defence of a fortress, as well as in the attack. The first comprehends all that precedes the opening of the trenches; the second extends from the opening of the trenches to the establishment of the third parallel; and the third comprises the remainder of the siege until the conquest of the place.

The first period is entirely employed in preparations on both sides; the second is called the *distant* defence, and the third, which includes the attack of the covered way, the passage of the ditches, assaults, &c. is called the near defence.

FIRST PERIOD OF THE DEFENCE.

Of the Preparations.

The investment is usually preceded by the place being put into a *State of Siege*. By this is understood the state in which it is placed when the government, believing it to be menaced, confides to its governor or commander the power of disposing of every thing in its circuit or neighbourhood, in as full a manner as if it were actually besieged. It is at this epoch that defensive dispositions, of the same nature as if the place were invested, must be commenced. (*Carnot.*)

Whether the place be declared in a state of siege or not, the governor must not wait until it be invested, or is about being so, before he busies himself with putting it into a situation to sustain a siege. As soon as he has reason to believe that he will be at-

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tacked, he must lay in provisions and other stores, repair all the works, magazines, &c. make dispositions to prevent surprise, and keep the investment at a distance.

We shall here suppose that the place is completely furnished with every thing necessary to a good defence, and shall treat elsewhere of the artillery stores and ammunition, the supplies for the troops, magazines, hospitals, and inhabitants, that may be needed.

At the same time, that stores and provisions of all sorts are attended to in all their branches, the first labours of the defence must be completed. These consist in the repair of the parapets, by re-establishing their slopes, banquets, &c.; in arming the covered way with palisades, the defiles with barriers, in fraising and palisading the earthen works that are liable to attack; in preparing every thing necessary for the communications from the body of the place to the outworks, by bridges, boats, rafts, &c., or by hurdles if marshy ground intervene. A large stock of fascines, saucissons, gabions, hurdles, pickets, heavy timber for blinds, must be laid in, and earth collected to make traverses within the works that may be attacked, and to repair the parapets during the course of the siege. Wood must also be provided to make the platforms, and the small powder magazines, that are established under the rampart in rear of the batteries; the cartridges filled, and fire works made.

The entrance and exit of water courses, sewers, and provisional passages, must be shut, to guard against surprise. The posterns and other openings into the ditch, that are not necessary, may be walled up.

The barbets of the salient angles of the works are put in order, and each of them armed with three pieces. These are of heavy calibers in the bastions of the fronts liable to be attacked, say 24 or 18 pounders, 18 and 12 pounders in the other bastions, 6 pounders in the half-moons, or even 12 or 18 pounders in the more important ones, and those at the gates from which it will be easy to withdraw them; a howitzer is placed on each capital. The cannon of these batteries serves to keep the investment at a distance, to prevent reconnoitring parties, and to fire upon the workmen who open the trench, on whatever side it may be done. It may remain on the barbets until the enemy have guns mounted on

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batteries to oppose it, as it has a superiority over any he can place in the open field.

A large mortar is placed in each of the bastions, and a smaller one in each half-moon ; the use of these are to throw fire-balls, to light up the environs if it be thought necessary. Some howitzers or mortars are also placed to penetrate into those hollows where balls cannot reach, and which the enemy may take advantage of, to advance upon the place with a view of surprising it. Cannon of small caliber are placed on the flanks, and in all places that look along the ditches, to prevent surprise and escalade. Cannon of large caliber may also be mounted upon the faces of the bastions that will probably be attacked, in a way we shall hereafter describe, that will enable it to remain during the whole defence.

The pieces are provided, at once, with about 30 rounds. Rampart guns are also of great service. These arms carry a great distance with accuracy, and are easily transported. If placed in the advanced works, or even beyond them, in hollows, behind bushes, &c. they may be employed to fire upon reconnoitring parties in the first instance ; and afterwards, upon the openings in the parallels and other passages, as well as upon every thing that is not well covered, yet beyond the reach of the common musket. If rampart guns cannot be got, rifles must be procured, and entrusted to the best marksmen.

Too many platforms cannot be provided ; they are never in any case in the way, and may be of great use. If embrasures are needed, they must not be opened until they are absolutely wanted. The commander of the artillery, who must have reconnoitred the whole exterior of the place, can almost always judge what front will be attacked ; nor can he well have any doubt that it will be one of two known fronts ; she will, therefore, easily see on what points the enemy must establish his batteries, and consequently where those to be opposed to them should be placed. We shall see presently, that if batteries are not prepared in advance on the probable points of attack, faced with saucissons as high as the genouilliere, and the cannon prepared and so disposed as to be quickly brought into battery, the besieger may get the start. In this case the besieged may not have guns to batter the besiegers batteries before their completion, or to fire upon the opening of the trenches, and may thus be exposed to much danger.

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The moveable artillery, 6 and 12 pounders, may be placed in reserve upon the curtains of the front of attack, to be employed as soon as it is needed, and the enemy within its reach.

The operation of clearing the neighbourhood of a place of every thing that can do harm, either by enabling those who reconnoitre to approach too near, or by favouring the progress of the approaches, and the establishment of besieging-batteries cannot be too soon attended to. On this account, all hedges, ditches, walls, houses, within 1000 yards, ought to be removed, at least all those that can by their situation hinder the defence.

As soon as the governor of the place is informed, by his spies, by the parties he daily sends into the country, and the movements of the enemy, that he is soon to be invested, he ought to carry into the fortress every thing of value to the citizens, or for the supply of his garrison, that he can find in the vicinity ; grain, forage, cattle, wine, workmen who may be useful in the defence, and all the men capable of bearing arms that he can find. He must also procure a quantity of wood; of this there can never be too much for the purposes of covering magazines, batteries, &c. and erecting shelters for the men, &c.

"He will next take possession of every advantageous advanced post, from which he may, by the fire of cannon, force the enemy to extend this investment, and give it such a large circuit that the bodies, in which his troops are formed, may be either too weak or too distant to prevent the introduction of aid, or the passage of advices, both of which will hinder the enemy's progress. These posts must have a communication with the place, that cannot be interrupted.

If such posts can neither be established nor maintained, it may be well, in order to deceive the enemy, as to his distance from the place, and induce him to establish his investment and camp too near, to fire on him with no more than half the usual charge in the pieces. If he fall into this trap, which, though well known, often succeeds, his establishments must be attacked with the most violent possible fire, so as to compel him to abandon them. This will occasion a delay in the preparations for attack, without reckoning losses. It may happen, that some circumstances of the ground, such as a stream, a deep ravine, &c. which separates the besieged from the enemy, will permit him to throw dismay into his camp,

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with cannon and howitzers of the largest caliber. At this first moment of the siege, a fortress should be put out of the reach of surprise. Its works must, therefore, be guarded with all vigilance and precaution. For if, as *Bousmard* says, you are content to keep behind your ramparts, you may have the enemy in your ditches, the petard at your gates or posterns, the scaling ladder upon your wall, before you are aware of it; and you will find yourself fighting him in the interior of the place, when he is least expected.

Bousmard recommends the following mode of guarding against surprises, and preventing reconnoitring.

" Besides the advanced posts without the fortress, he places 15 men in each re-entering place of arms of the covered way, who send to the right and left parties of five men each, behind the traverse nearest to the salient angle. By means of these three little posts, and their three centinels, the covered way of each front is well guarded. He posts, besides, in each of the two re-entering places of arms, at the gates of the place, 15 horsemen, who send patroles out every hour during the night, and in the morning sally out to make discoveries.

" As soon as any one of the posts has given the alarm, the artillery who are on guard near the great or small mortars that are within reach, (he places these in the salient places of arms and in the half-moons,) must throw fire balls, and those posted in the neighbouring barbets will immediately point their guns, and fire at any thing they may discover by the light of these projectiles. To make the security perfect, and not trust the safety of the place to the vigilance of these out-posts, that sleep or desertion may render useless, he places in each flank a small detachment of 10 men ready to fire on any thing that may appear in the ditch. Each of these detachments places two centinels on the parapet, which establishes a chain round the whole rampart. A bivouac of half the number of this extraordinary nocturnal guard, say 150 men, will be ready to march to the rampart of the front attacked, until the garrison have time to arrive, if the attack is a real one. This service of the covered way, joined to that of the out-posts, of which we shall speak presently, continues until the opening of the trenches. After that, the exterior service ceases, and that of the covered way is regulated in another manner."

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It is to be presumed, (says *Vauban*,) that the governor will have taken care to provide himself with a cypher to give intelligence to the general of the army, and to the neighbouring towns; and that he will have agreed upon signals to correspond from the highest steeple of the place, with one or two in the neighbourhood. From this steeple he may also, with good glasses, observe the motions of the enemy, see when he makes his preparations for attack, when he has established his depots of fascines. (But all this may be better known by means of spies.)

All these dispositions being made, the enemy may be coolly waited for, until it be time to retard the investment, trouble his communications, attack his depots, and thus compel him to cover himself when at a great distance, to act with circumspection, and so lose time.

A council of defence is formed; they are put in possession of a plan exhibiting the neighbourhood of the place to a distance of 4000 yards. On it are to be found, the villages, farms, &c. the places which may answer for the establishment of the great parks and the depots of fascines, the bottoms, ravines, and their distances from the place. The original disposition of the batteries, and the successive changes, are marked upon it from time to time. The labours of the besieged, and the new works necessary for defence, are also marked upon it. This council also keeps a journal of the several operations, so as to form a history of the defence, and render an account to government of every thing done during the siege.

The commandant of the artillery makes out a descriptive memoir of the stores and equipments needed by his corps. In like manner, the engineer hands in his memoir on the works that are to be executed, and the defence, as far as he is concerned. These two chiefs, on whom depends almost all the defence of the place, ought to understand each other, and aid in the dispositions to be made by the two arms. The commissary at war examines and takes an account of the stores, the provisions, the medicines, and the hospitals.

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Beginning of the Defence.

The enemy having completed the investment, the besieged must seek to prevent the place from being reconnoitred, and ascertain whereabouts the great park of artillery, and the depots of fascines, are established. This last will show the time and the place very nearly where the trench is to be opened. For this purpose, about 100 men are placed 800 yards in front of the covered way, on each front, in places covered by the fire of the body of the place. These detachments must have centinels so posted as to see every thing that passes in their front, and must send forward some steady and intelligent men to discover the place of the depots of the besieger. The artillery of the barbets must keep an eye on these detachments, so as to be ready to protect their retreat. It will also be aided by cavalry in front of the barriers of the gates and by detachments, of 20 men each, posted in each salient place of arms of the covered way. In the evening, these detachments approach within 250 yards of the covered way, so as to have a more secure retreat; they send patroles, however, as far forward as possible, and even single men, to listen if the enemy is about to open the trenches. Both by day and night these detachments will not fail to let single men, or very small parties, pass them, if they attempt to approach the place; by this means they may make them prisoners, and obtain information, when they are so far engaged as not to be able to retire. (*Bousmard.*)

In the day time videts are placed in the most open spaces.

At this epoch, double attention must be paid to see that the service is performed with the greatest punctuality; the citizens are enrolled, as we shall explain hereafter, and suspected persons placed under a strict inspection, together with every thing that enters into the place. The gates of the city, now become useless, must be masked by parapets of fascines fraised, and every precaution taken against attacks by storm and escalades, which the enemy may probably attempt, in order to save a long seige.

Bridges of communication, the wood of which must have been prepared in advance, are to be established. Not an instant must be lost in constructing, before the enemy opens his fire, the paradoses and traverses intended to cover from enfilading and reverse

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fires, as well as the arrows at the foot of the glacis. If this labour be delayed, it will have become dangerous under the enemy's fire. Haste must also be made to make the tambours of the communications of the covered way, to place its double palisade, to make reducts in the places of arms, and in those half-moons that have none. After this, retrenchments may be made in the bastions and in the stone reducts of the great half-moons.

The chambers of the mines must also be made, if there be none prepared beforehand, for the purpose of blowing up the batteries in breach and counter-batteries, and of clearing the foot of the breaches from rubbish.

The most pressing of these labours must be executed on the front of attack, if that be known, before the trenches are opened; if the front is still undetermined, every thing must be prepared to commence them the moment the attack is begun; and this ought to be done in whole or in part before the besieger's batteries open their fire. We shall now proceed to give a synopsis of these different works.

Traverses are constructed with gabions, (see vol. 1. *Construction of Batteries.*) They are placed between every two pieces, or, at farthest, between every three; they ought to be a foot higher than the parapet, 4 yards thick, and 8 yards long, so as to shelter the gun carriages from the fire of the besieger to the utmost limit of the recoil.

Paradoses, for the purpose of sheltering from reverse fires, as they are shown on the flanks of the bastions attacked, (fig. 68.) are also constructed of gabions, but it is better to make them of posts and the trunks of trees.

Arrows or *fleches* are constructed, at the foot of the glacis, upon the capitals of the bastions and half-moons. They are formed of two faces of 30 or 40 yards each within, which are flanked by the covered way. (pl. 7. fig. *f.* and profile pl. 9. fig. 81.) When they are constructed with gabions, they are soon made, and if fraised on the side of their ditch, and palisaded at the gorge, the besieger must storm before he can penetrate beyond them, to lodge himself on the glacis.

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Small Powder Magazines, for the daily consumption of the batteries, are constructed under the rampart, one under each face, one under each flank, and one under the curtain of the works of the front attacked. (See *Construction of Batteries*, vol. 1.)

The covered way is sometimes armed with a Double Palisade, the second range of which is planted on the terraplain two feet from the slope of the banquet, and reaching from traverse to traverse. It has a banquet behind it of sods or fascines, or else the palisades are afterwards of different heights, to permit the fire. This parapet leaves a second defile between it and the counterscarp, to which the troops forced from the other may retreat, and dispute the branches of the covered way. (See pl. 8. fig. 73. the right branch before the half-moon, and the profile on the line *d p*. fig. 82. pl. 9.)

The retrenchments of the salient places of arms of the covered way, cannot be formed of earth, on account of the small space afforded for the purpose; they are, therefore, made of trunks of trees, blinded and covered with sand bags. They are block-houses of the same kind as has been described in *Field Fortification*. A block house of this sort retarded the taking of the covered way more than 8 days at the first siege of Dantzic. The stair-cases only are sometimes covered, which is done by a tambour of carpentry, (profile fig. 83.) formed of planks placed close to each roof to throw off by an inclined palisade, and covered by a small other, defended hand grenades. That part of the planks which is above ground is covered with tinplates to preserve it from being burned by fire-works.

In those re-entering places of arms that have no reducts of masonry, good reducts of earth are, if possible, made, and raised from 2 to 3 feet higher than the glacis; their scrap is faced with fascines and fraised, and their counterscarp lined with planks, sustained by piles, like the places of arms 6 and 9. (pl. 7 and 8. and their profile fig. 84.) It might perhaps be better to support the scarp of their ditch with planks, or large palisades. But if these works cannot be made, block houses must supply the want of them, or even tambours of wood to cover the stairs of the counterscarp, as is shown at No. 9.

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The RETRENCHMENTS of the bastions are made by a cut *r*, pl. 8. behind the bastion, and reaching from one flank to the other, in form of a tenail, or any other figure. Or it is better that it should go from one shoulder angle to the other, so as to preserve the use of the flanks, as in the bastion No. 2. Their ditch is made like that of the re-entering place of arms above described; the counterscarp may have upon it a sort of covered way, formed by gabions and palisades, into which the troops that sustain the assault have a secure retreat. When there are houses behind this, they are pierced with loop-holes, and the streets are broken up or barricaded.

The retrenchment *r* of the reduct of the half-moon, may be made in the same way; sections *c* are also made in the faces to preserve the parts, between the gorge and the breaches, that cover the re-entering places of arms and their reducts, and which may delay the establishment of breach batteries against the bastions. But if it be not a great half-moon, with a reduct of masonry, the retrenchment is of the form of a reduct; or nothing more than a smaller half-moon made in the same way as the retrenchments of the bastions, if the interior of the half-moon be full. If the interior of the half-moon be empty, this retrenchment would be commanded by the rampart, and no other can be made than a tambour or palisade, (as is shown in the half-moon 5,) to cover the retreat through the caponnier.

The posterns that communicate from the principal retrenchments to the exterior are made of wood work in the form of a double caponnier. (See *Field Fortification.*)

"OF MINES. Whether the place threatened be provided with counter-mines or not, miners must be sent to it, so that this powerful means of prolonging the defence may not be wanting. (*Bousmard*, vol. 3.) If it have counter-mines, they may begin their labours sooner, and act at a greater distance; they may also conduct their subterranean war, against the besieger and his works, with more safety and obstinacy. If there are no counter-mines, they will do all that the time will allow them to undertake.

"If we suppose, that the place have no counter-mines, and that there are no more than 42 miners, they may undertake a double T (pl. 7. *m*, *m*,) under each salient angle of the covered way, to blow up the lodgment and the counter-batteries. A double T

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under each branch of the covered way opposite the faces of the bastions of the front attacked, to blow up, in like manner, the lodgment and the batteries in breach established there. And, lastly, mines under the ditch of the same bastion faces, at the place they are probably to be breached, for the purpose of clearing off the rubbish from the foot of the breach.

Before the trenches are opened, wells should be dug upon the salient angles of the covered ways of all the works liable to attack, in the branches, and in each bastion, in order that the subterranean war may be begun without loss of time, as soon as the front of attack is known. These wells may be opened on the banquets; those in the covered way must descend 1½ feet below the ditch, and those in the bastion 12 feet under the bottom of the ditch.

"The front of attack being known, three branches are pushed forward from each of the wells in the three salient angles of its covered way. (pl. 7. fig. 68.) One of these is along the capital, 8 yards in length, terminated by a T, each branch of which is 5 yards long. The two other branches are perpendicular to the first, and 9 yards long. The line of least resistance at their extremities is 16 feet. From each well of the branches of the covered way there are made three other branches, one perpendicular terminating in a T, the other two parallel to the crest. A fourth branch is opened from the counterscarp, to the bottom of each of the wells, to serve as a communication between them and the ditch; the well is then filled up.

From the bottom of the shaft of the bastions, a branch is carried under the foundation of the revetment, terminating in a gallery parallel to the foot of the scarp, and distant from it about 15 feet. It extends 12 yards each way, and has 6 branches returning 9 feet towards the scarp, and rising in such a way as to permit the establishment of chambers at their end, whose line of least resistance shall be 6 feet. Four other mines are established along the gallery, whose line of least resistance is 12 feet.

"Boxes of powder must be buried under the ditch of the half-moon, opposite such places as may be breached, at the distances of 6 feet, and 15 feet from the scarp, and the respective depths of 6 and 9 feet.

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"The branch of the capital of the three salient angles of the covered way may be carried forward far enough, to reach beneath the position of the trench cavaliers, before the enemy has progressed that far; a T will be then made 6 yards each way, as is shown in fig. 68. The enemy will be awaited here, and compelled to engage in a subterranean war.

"If arrows are made on the salient angle of the covered way, mines may be prepared to blow them up when the enemy shall have taken them, and thus prevent him from sheltering himself in their ditch, by means of traverses. For this purpose, as soon as the arrow is traced on the ground, boxes containing 20 or 25 pounds of powder are sunk to a depth of 6 feet under the place of the parapet, at the distance of 15 feet from each other, and their troughs, sunk 6 feet into the earth, meet a trough in the direction of the capital through which fire is communicated to them.

"To prevent the besieger from ruining the mines through their openings in the counterscarp, the troughs must be continued to the rear of the tenail, in trenches cut at the bottom of the ditch for that purpose, and 6 feet deep; the mines must be charged as soon as the enemy begins the 3d parallel, and the entrances from the counterscarp walled up.

"Forty-two miners, with 140 assistants, working for the 12 first days of the siege, and expending 3,300 pounds of powder, will lengthen the defence 22 days.

SECOND PERIOD OF THE DEFENCE.

First disposition of the Artillery.

When the investment has been complete for some days, and the time for the opening of the trenches is probably at hand, shells charged with fire-works, fire-balls, and carcasses, must be thrown every night, and during the two or three first hours in particular, in such a way as to light up the whole circuit of the place, at the distance of about 600 yards. This will serve to show if the enemy is beginning his works. As soon as he is seen endeavouring to establish himself in any direction, the warmest possible fire must be directed to that point from all the pieces that can be brought to bear, and grenades thrown from the advanced works upon the

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workmen. Besides the barbet batteries, and the mortars, of which we have already spoken, other cannon must be established upon the front to be attacked, if it have been ascertained before hand. If there be no certainty on this subject, this must be done with all those fronts that may be attacked. In all cases, the moveable artillery of the place must be disposed in such a way as to be readily transported into the works to fire upon the attack. As there will be no embrasures for these pieces, they may be placed a little behind the parapets, so as to have a plunging fire over them, at an elevation, and with small charges of powder. It may be observed that the barbets are unsafe for the men, if an enterprising enemy open his trenches as near as the French once did before a Dutch fortress. (Wenloo, I think.) It is, therefore, proper to have gabions and sand bags in readiness, to form embrasures to the barbets the moment they are needed, or to raise the inner crest of the epaulment on each side of the pieces, in such a way as to place the artillerymen out of the reach of musketry.

Artillery manœuvring with howitzers, and supported by cavalry and infantry, ought to sally out at night from the place upon the flank of the approaches, to enfilade the troops that cover the workmen, and throw the latter into disorder. Infantry, with light field-pieces, may sally out at the same moment from the covered way, to attack the covering troops in front, taking care not to advance so far as to be compromised. Besides the loss that such a manœuvre will cause the enemy in men, it will reduce the labour of the night to a trifling quantity, and cause the labourers and the troops to be exposed, during the day, to the fire of the place. As soon as the sortie has returned to the covered way, the artillery will again open a warm fire upon the enemy's workmen.

During the day, the besieged will be best occupied in directing and multiplying his fire upon the approaches of the enemy, whose progress is known to him. At day-break, he will examine with care, from every point, the state of the work, and will direct his fire upon those parts which are only planned out, so as to prevent their being finished during the day, and give an opportunity of again destroying the work during the night. He will examine if he can enfilade or batter diagonally any part of the approaches; and will advance from the place, upon the flanks of the attack, in order to take up some position, from which he can fire along the

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zigzags of the enemy, where he will erect either an embrasure or a barbet battery, such as *p* and *q*, with which he will communicate from his covered way by a trench. This species of work is called a line of *counter-approach*. It is usually commenced at the glacis of the half-moon of the collateral front, and advances into the country. (fig. 68, half-moon 5.) It must be lined with musketry, to enfilade the trenches ; but this line *l*, is more frequently terminated by a battery *p* in form of a fleche, which is pushed forward 80 or 100 yards, so as to take the works of the enemy in flank. (*Bousmard.*)

The opening of the trenches no longer leaving any doubt as to the front of attack, (if there be but one,) no time ought to be lost in providing it, as well as those collateral faces that bear upon the attack, with the greatest possible number of guns.

These will batter the position for the batteries, and retard their construction as much as possible, because the moment they are established, those of the besieged, taken in flank, diagonally, and in reverse, will lose the advantage they had previously possessed. He must, therefore, not fail to profit by this opportunity, and should not spare his ammunition while the batteries are constructing, which is an affair of 36 hours. He ought, of course, to take measures to know exactly both the time when, and the place where, the enemy commences their erection.

Howitzers and 8 inch mortars should be placed in the salient places of arms of the covered way, and field six pounders to fire ricochets over the palisade, along the capitals ; a direction in which they will successively meet all the zigzags of the approaches. The heavy guns are to be placed on the bastions of the front attacked, and some, also, upon the collateral bastions, if they can thence act to advantage against the works of the besiegers. Six and 12 pounders and howitzers, are to be placed on the half-moons, along with 12 inch mortars ; the remainder of the guns upon the centre curtain, to execute plunging fires ; the heavy mortars on the ramparts of the bastions, and on the curtain to harass the batteries. The howitzers will fire upon the work of the batteries, and upon the head of the saps. The pieces of reserve, placed for the most part, upon the curtain, will be in readiness to be carried to any other front, if the enemy open his true attack there, which the other was intended to conceal.

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We suppose our fortress armed with 48 guns, of which one half are 24 or 18 pounders, the remainder 12's and long 6's; and at least 24 howitzers, mortars, and stone mortars; besides 12 small field pieces, to be used in sorties, and on the covered way, and that are not counted in the armament of the front attacked, any more than the small mortars that may be provided for the near defence.

Second disposition of the Artillery.

The disposition which was at first given to the artillery in order to scatter its fire; and the subsequent concentration of it upon the faces of the works of the front attacked, as soon as that is known, in order to batter the position of the siege batteries and their construction; must be altered as soon as they are established. The pieces must then be disposed in relation to the progress of the attacks, and to the case with which they can be moved; they must be removed from place to place, according to the exposure, and to put them more completely out of the reach of the enemy's fire. For this reason, the batteries *p q*, raised on the flanks of the attack, must be abandoned and razed, unless they are tenable, in which case, their guns, which are carried during the day into the covered way, may be replaced in them at night. For the barbets of the salient angles, embrasures must be substituted, if the guns are not mounted on garrison carriages. As soon as the besiegers batteries are in full action, the artillery of those points most exposed to their fire must be removed, and placed in shelters prepared for that purpose beforehand; the 24 pounders of the bastion faces must be placed on the collateral flanks, looking towards the attack, and fire ricochets upon the approaches and the batteries; the two flanks of the front attacked, must be sheltered from reverse fires by paradoses. If the pieces upon the bastion faces are still too much harassed, a part may be withdrawn and placed on the curtain attacked. Bombs should be thrown as ricochets along the zigzags from the mouth of long guns, or from eight inch mortars placed upon gun carriages, on the capitals of the salient angles of the bastions, or if this cannot be done, howitzers must be placed there for the purpose.

The artillery will then be posted thus, (pl. 7. fig. 68.)

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On the faces of each of the bastions No. 1 and 2, to batter the approaches, and the batteries directed against these faces and the adjacent half-moons, six 24 or 18 pounders, one of which is directed along the capital to fire shells as ricochets, (if there be no mortar mounted on a gun carriage,) or else a howitzer, or even two, (if to be had,) are placed there; two heavy guns in the prolongation of the crest of the covered way to be ready to enfilade the lodgment on the covered way, and batter the trench cavaliers; five 24 or 18 pounders on the right flank of the bastion No. 1, and as many on the left flank of No. 2; a 12 inch mortar at the shoulders. Two or three pieces may be placed upon the face adjacent to each of these last named flanks, if the extreme batteries of the attack can be thence reached, and two more upon the curtain to fire through the gap between the tenail and the flank of the bastion. The artillery thus dispersed, will be less exposed.

Upon the flank of the two collateral bastions, two 24 or 18 pounders to strike the besiegers approaches diagonally, and reply to the batteries of the centre of the attack.

On the half-moon of the centre, six 6 or 12 pounders, and a howitzer on the capital. The artillery is there more exposed to be harassed by the fires of the enemy which cross upon it, than elsewhere. Taken both in flank and in reverse, it cannot be maintained, unless sheltered by traverses and paradoses; but if it be dislodged thence early in the siege, it must again return, because the trench cavaliers, and the lodgment on the crest of the glacis of the bastion, are better enfiladed and battered from that position than any other place.

On each of the collateral half-moons, three 6 pounders and an eight inch mortar; some of the 12 pounders, from the faces of the bastions, may also be placed there, if too much harassed, or of little use against the attack.

In each salient place of arms of the front attacked, at least one howitzer and two 8 inch mortars, whose shells may be thrown as ricochets.

In each of the two collateral salient places of arms, one howitzer and two 6 pounders, or three 6 pounder field pieces.

Even if the other fronts have no need of artillery to defend themselves, or guard against surprise, there must be one 12 or 6 pounder, at least, at the extremity of the collateral fronts, in order

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to flank them, hinder the besieger from approaching within striking distance, and compel him to make long circuits out of the reach of the cannon of the place, in order to arrive at his attacks, or communicate from one of his quarters to another.

The besieger having reached his second parallel, the position in which he will probably place the new batteries he must construct, in order to produce more effectual fires, must be battered with the whole of the artillery.

It is more easy to disturb the work of the second parallel by sorties than the first, for as it is exposed to the musketry of the place, the besieger can cover it by a few platoons only that have already suffered from the fire, and he may be compelled to proceed by the sap proper, which takes a long time, and the work retarded in consequence.

When the half-places of arms are established, and their batteries ready to fire, the howitzers and mortars in the salient angles of the covered way of the front attacked must be replaced by small mortars that throw grenades. One or two of these are placed in each place of arms of the covered way of the front attacked, and in the two collateral re-entering places of arms. These small mortars cannot be too much multiplied; they annoy the besieger excessively, and being very light, they may be placed, displaced, and carried with ease in every direction. Six stone mortars at least must be added, which will produce a more multiplied and frequent effect, than the last mentioned pieces, on the approaches of the enemy, that will soon be within the reach of this weapon. The howitzers may be placed on the bastion faces of the front attacked, in such a way as to enfilade the lodgment on the crest of the glacis, and in the mean time they will fire upon the approaches to this lodgment. One of the large mortars must be placed in each of the collateral half-moons, the other in the half-moon of the centre. If there are no small mortars, an 8 inch mortar to throw grenades may be put into each of the reducts of the re-entering places of arms of the front attacked.

At this epoch, the besieged, being so near the works of the besieger, ought to make frequent sorties to interrupt his labours, and should endeavour to raze them, and to spike his guns.

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THIRD PERIOD OF THE DEFENCE.

The epoch of the establishment of the third parallel, is that in which the defence must assume still more energy. Until this time, it has been too hazardous to sally out and attack an enemy superior in force, far from the fortress, and intrenched in his works. Neither would it have been possible to destroy them by the fire of cannon, for the whole ammunition might have been wasted without producing the effect. No more has of course been done, than to harass him and retard his progress. But at this epoch, when the besieger invades the very ground of the fortress, the governor must, under its protection, become now much more valuable, employ the whole active force of his garrison, and the resources of his own genius. As *Gay de Vernon* says, "Up to this time he will have economized his ammunition, and other defensive preparations; but now he must not neglect to dispute foot by foot, every portion of the ground contained within the probable field of battle. In the mean time, the progress of the besieger becomes slower, more difficult, and more dangerous. The besieged ought to direct all his efforts to retard the construction of the third parallel; he must, in consequence, attack the besieged vigorously, with frequent sorties, and the artillery of the place.

"There is only one way, (says General Carnot,) of completely arresting the progress of the besieger, which is to destroy his works as fast as he makes them, and thus prevent him from surrounding the place on every side, and closing more and more upon it every day. This object can only be attained by main force. Every thing must then be planned to aid a succession of attacks. We must always, in war, (says the GREAT FREDERIC,) desire that which is not desired by the enemy. In the case of a siege, what is it that the besieger does not wish? It is a series of unforeseen attacks. His object is always to chase you with method, and inch by inch, from all your positions, while yours must be to compel him to attack you. What is it the enemy's interest to avoid? Acts of enterprise; they must then be multiplied. What is it that experience has shown to be for ever fatal to him; and what is it that has always produced excellent defences? Combats of man to man. The besieged must then restore the use of these combats; and instead of regarding every thing of that sort as an accessory, make

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it the principal object, and look upon all the rest as secondary; not indeed to be entirely neglected, but as subordinate to the other, which is the chief object, and calculated to render it more valuable.

"Let us feel the spirit of this method, (adds Carnot;) It does not consist in obstinately disputing a work, where a weak garrison must strive with a superior force, but in always opposing strength to weakness. When the enemy attacks you, either by storm or gradual approaches, and brings into action numerous troops, the ground must for the moment be given up to him, and he must be left exposed as long as possible to the hottest fire of all the neighbouring works, which must be prepared for that purpose. If he persist in remaining in the work he has taken, he will lose his whole detachment. If he retire, the besieged may then return with all possible vivacity, push him back at the point of the sword, and overthrow his lodgments, without running any risk; then return quickly, so as not to be exposed to the fire that he will open as soon as he has effected his retreat.

"If, on the contrary, the enemy approaches regularly, if he search to enclose you by his places of arms, and half places of arms, those insensible advances, that are so frightful from their continuance both by day and night; then the immense extent of his works allows you to fall unexpectedly, sometimes on one point sometimes on another; you attack the head of his saps, always ill supported, because if he placed many soldiers there to protect them, the fire of the place would be very fatal; you may safely pierce his trenches and his lodgments on the covered way, that cannot be guarded at every point; you will convey thither a strong detachment, not as during the first periods of the siege, merely to interrupt the works and make the labourers fly, but to kill them and destroy their labours.

"In a word, it is by a continual alternation between lively attacks and the fire of batteries, that the works of the besieged are to be stopped, or at least much retarded."

"It is towards the end of the siege, (says Marshal Saxe,) that more vigour than ever is to be displayed, because then actions of main force may take place. The more vigour you show at this time, the more it will discourage the enemy, because maladies will now break out in his camp, provisions and forage become scarce, and every thing, in short, go to destruction. All this will dis-

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courage both officers and men. If they find in addition, that the resistance becomes more obstinate, and augments as they expect it to diminish, they no longer feel the same confidence, and are at length totally disgusted. On these accounts, the best troops must be reserved for sorties, and not permitted to fatigue themselves with any other service."

When the besieger undertakes the third parallel with the sap proper, the besieged ought, as soon as any considerable portion of it is erected, to cause troops to march out from the collateral works to cover the flanks of the manœuvre, and others from the front of attack to fall upon the sappers of the enemy. These troops will maintain the ground they may take up, until the labourers they protect from the enemy, (who will advance from his half places of arms,) have razed the works, and retired again into the covered way.

Small sorties may also be made, that are only meant as alarms, but which will be sufficient to put the sappers to flight, and of course retard their labour.

Balls and grenades must be frequently fired, and good marksmen should line the covered way and keep up a continual and well-directed fire upon the heads of the sap. The cannon, in the covered way of the collateral salient places of arms, will batter the work diagonally.

Third Disposition of the Artillery.

The artillery in the covered way must be withdrawn before the besieger completes his third parallel, because they will then be liable to be carried by storm. The howitzers will be placed in the bastions, and the stone mortars below the rampart, in the flanked angles of the bastions and the half-moon of the front attacked, so as to be secure from the ricochet. The small mortars may be placed in the reducts of the re-entering places of arms of the front attacked, or in the dry ditch behind the rounded angles of the counterscarp. They must be removed still farther back when the enemy masters the covered way. As many stone and grenade mortars as possible must be provided, to overwhelm the lodgments of the enemy by those projectiles. These curved fires will do him much more harm than direct ones. Stone mortars,

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therefore, should have been kept in store to be exchanged for the long guns at this period.

While the besieger is constructing his batteries in the third parallel, the besieged ought, without diminishing his fire, to repair his batteries and parapets. This is done by reinforcing from within those that the enemy's fire has weakened from without. If it be necessary, the battery may be sunk into the terraplain of the rampart. Oblique batteries may be established on the curtains of the front attacked, if it has not been already done; they fire diagonally upon the crowning of the covered way, in concert with those on the collateral curtains. These batteries will, at a later period, batter the passage of the ditch. Similar batteries must also be made in the collateral half-moons, to enfilade or take in reverse the places of the counter-batteries of the lodgment. These batteries may all be blinded, and the enemy thus compelled to lower his counter-batteries into the covered way. The flank batteries may also be blinded, and it must be attempted to do the same at the flanked angles of the bastions, to take in reverse the crowning of the covered way of the half-moon. The bombardiers of the mortar and stone mortar batteries may be sheltered from the curved fires of the besiegers, by means of a sort of roof formed of planks or hurdles covered with sods, that may easily be established over them without impeding their fire.

Three pieces are withdrawn from each bastion of the front attacked, to arm the curtain. In the half-moon, the pieces are placed behind the cuts of the faces, to fire into the covered way, batter the lodgment, and the batteries. The pieces in the two bastions will batter the lodgment in front of the half-moon, and the howitzers in the shoulders will enfilade the ramparts of each face of the half-moon of the front attacked. We have already seen that the batteries in breach, and counter-batteries, are also battered, by the flanks, the curtain of the front attacked, the collateral curtains, and their flanks.

As soon as the besieger has established himself in his third parallel, the storm of the covered way is to be expected, particularly if he take great pains to finish this parallel, if he form steps for the passage of troops, and arms it with numerous stone mortars.

It becomes necessary then to light up the parallel by night with fire balls, to place good troops to throw grenades in the reducts

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of the places of arms, and along the parapet of the covered way, as well as in the ditches of the bastions and half-moon. The parapets of the place must be lined with musketry, and a quantity of crows-feet thrown upon the glacis, to hinder the besieger from entering the covered way easily, and to keep him exposed to the fire of the besieged. When the enemy marches out from his parallel, he should be met by an overwhelming fire of artillery and musketry. The infantry, upon the banquet of the covered way, will retire, (after having made one close discharge,) behind the second row of palisades, so as to leave the enemy exposed to the whole fire of the place; from its new position, it will keep up the most lively fire. If there be no second row of palisades, this infantry retires into the re-entering places of arms, and the ditch. The enemy is then saluted with the whole musketry, and the artillery of the place, loaded with grape and grenades; when he shall have been disordered by these, the troops in the re-entering angles will attack him in the covered way, followed by those in the ditch, and will drive him out and destroy the works he may have commenced.

If the besieger attack the covered way by regular approaches, a warm fire must be kept up on the heads of his saps, along the capitals, and upon his batteries. Grenades and stones are thrown in quantities upon the workmen and the troops in the trenches; the works are lighted during the night to direct the fire, and guide the sorties. As soon as the trench cavaliers show themselves, a fire is opened upon them, particularly from the oblique batteries.

Where the enemy seizes on the salient angles, the besieged retires to the re-entering places of arms, defending himself from traverse to traverse, with musquetry and grenades. These traverses are battered down when abandoned, to prevent the enemy making use of them to cover his descent of the ditch.

As soon as the enemy seem to begin the descent of the ditch, shells, howitzers, grenades, &c. are thrown against it.

When the besieger appears upon the crest of the covered way, it will no longer do to restrict the guns to a certain number of rounds per day, but each piece must fire as often as possible, to prevent the enemy from establishing his batteries, and afterwards to destroy them, or, at least, oppose them vigorously and diminish

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their effect. Good marksmen, looking over the ramparts, pick out the gunners.

The artillery in the half-moon and its reduct, must not remain until a practicable breach be made in them, but successively withdraw. Four of the pieces must be removed to the middle of the curtain, to fire into the half-moon, and especially upon the top of its breach. The stone mortars will first be withdrawn into the reduct, and then behind the curtain, to throw stones into the interior of the half-moon. The rest of the artillery is placed on the bastions of the front attacked.

As soon as the mouth of any one of the descents of the ditch is known, a battery is to be established at some place where it can be battered, so as to render both it and his works of the passage of the ditch, difficult to the besieger. If the ditch is dry, this epaulment is, besides, attacked by frequent sorties, which leave the caponniers in front of the tenails, creep along the counterscarp, then fall suddenly on the workmen, and overthrow their labours. But if the ditch is filled with stagnant water, sorties cannot be used, and the defence is limited to the artillery. This case is disadvantageous to the defence. A ditch that can be filled with water at pleasure, and that, in particular, where strong currents may be introduced by the play of sluices, is much more advantageous, because the qualities of a dry ditch may first be made use of to impede the passage of the ditch, and afterwards the action of the water to carry it off. The epaulment of the passage is, in this event, made of combustible materials, and may, of course, be burned, by means of fire-works. (*Bousmard.*)

When the besieger has possessed himself of the half-moon, the warmest possible fire is made upon him from both the faces of the bastion, and the curtain. Afterwards, when he has effected a breach in the reduct, detachments are placed on each side of it, to prevent him from making a lodgment by gradual approaches, and compel him to give the assault. If he mounts the breach in force, these detachments make a close discharge of their arms upon him, and retire into the retrenchment. And, finally, after he has got possession of the reduct, the fire is continued, to trouble his approaches along its faces.

The besieged keeps up a fire of musketry from behind the retrenchment, and throws a quantity of grenades; but when he sees

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the enemy prepared to scale the parapet, he retreats through the caponnier to unmask the guns on the curtain, unless he feel strong enough to await the assault.

The besieged may expect the assault to be given to the body of the place, and the retrenchment of the reduct, at the same moment, and must prepare himself in consequence.

Of the Defence of the Breach of the Body of the Place.

We shall suppose that the governor wishes to make an honourable defence, and that he has, in consequence, made a good retrenchment in the rear. If he have not done this, the place would have no hope of safety when the breach is once forced. On the contrary, if there be a retrenchment, (says Carnot,) the body of the place may be several times taken and retaken, and it is a succession of vigorous acts of this sort that finally forces the besieger to retire, when the defence is ably conducted.

In order to meet the assault, the retrenchment in the rear must first be armed with guns, mortars, and stone mortars, to shower their projectiles on the besieger, as soon as he has mounted the breach; musketry must then be placed on the parapet to keep up a continual fire. The breach must be studded with crows-feet, or planks full of nails projecting at least 3 inches; and these planks, to be of the utmost value, must be thick, and fastened together by chains, so that they may not be removed. Shells, exploding barrels, barrels and sacks of powder, must be placed near the breach, to be rolled down upon the storming party, and howitzers to fire large charges of musket balls upon the head of the column as soon as within reach. The breach must also be shut by chevaux de frize, or six pointed stars, to arrest the progress of the enemy, and keep him exposed to the whole of the besieger's fire. Large fires too may be made, as we shall presently see. On the two sides of the breach, behind the parapets, platoons of grenadiers, whose retreat is secured, keep a constant fire on the passage of the ditch, and throw a quantity of grenades, to prevent the assailant from clearing the rubbish from the breach. While the head of the column is exposed to all these blows, those at the bottom of the breach, and in the ditch, are exposed to numerous flanking and vertical fires; and the batteries of the collateral works do not cease to shower shells and balls

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on the covered way, and the communications of the third parallel, where the manœuvres of the besieged must be executed.

As soon as the enemy shows himself on the top of the breach, he is charged by a detachment of chosen men; but if this effort do not suffice to repulse him, the defenders retire quickly to leave him exposed to the fire of the retrenchment. If he should be thrown into disorder by the multiplied fires from every point that sees the top of the breach, a sortie must be made in strength to retake and repulse him from his lodgment in the breach, if possible, so as again to defend it, and renew the difficulties of the assault to the besieger.* If the enemy finally succeed in lodging himself on the breach, he is still resisted by every possible means, until he have made a practicable breach in the retrenchment. No capitulation must be made until that time, nor even then, if there is a second retrenchment to retire into, in order to continue the defence, after the first shall have been stormed.

"If the besieged thinks he may await the assault without retrenchments, he must keep himself constantly in readiness to adopt the following disposition, the time proper for which he will be advised of by signals from sentinels at the top of the breach, and on the flanks. (*Bousmard*, vol. 1.)

"Two bodies of troops of a certain depth, well supplied with grenades, will march to the two flanks of the breach, whence their last ranks will not cease to throw grenades upon the assailants as they mount, nor their first to fire their muskets, as soon as they show themselves. If, in spite of this shower of missiles, they reach the top of the breach, they must instantly be attacked by a body of men chosen for their personal strength from the rest of the garrison, covered with defensive armour, and provided with long weapons, such as pikes. The last ranks will still continue to throw grenades upon the assailant, over the heads of this detachment. Fresh troops must be kept in readiness to sustain the first, and to take their place in case the assailant, being once repulsed, renews the attack. The besieged can hardly sustain such an assault, unless the breach is narrow and barely practicable, when

* At the siege of Candy, the same work was taken and retaken 36 times, and cost the Turks 25,000 men.

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he has every advantage on his side, or when the enemy has neglected to cover the passage of the ditch by an epaulment, so that his flanks are exposed to a deadly fire."

General Carnot, in his Treatise on the Defence of Places, proposes that stars with six points shall be used instead of chevaux de frise, which are difficult to manage. These stars weigh no more than from 10 to 30 pounds each, so that a single man may carry and place them any where.

"In order to make one of these stars, it is only necessary to take three small sticks of fire-wood, either round, or split, and two or three feet long; or three staves of the same length, as thick as one's thumb. These must be arranged perpendicularly to each other, by dovetails of half their thickness, and held together by strong nails, bolts, or merely pins of wood. The ends are cut to a point, and armed with a sharp iron.

"Whenever it is wished to arrest a sudden movement of the enemy, two or three ranges of these stars, locked into each other, will form a sort of cheval de frise, that is better than a palisade, and may be removed if it be wanted elsewhere.

"We must not omit," says Carnot, "another excellent method of arresting, for a time, the impetuosity of the assailant at the top of the breach. This consists in digging, along the whole breadth of the breach, a large and deep ditch, that is filled with fire-wood, pitched faggots, and all sorts of combustible matter. The time of the enemy's commencing to mount the breach, is watched, and this mass of wood is then fired on every side. Fire-works and small bags of powder are cast into this fire. As long as it can be kept up with activity the enemy is compelled to halt, and remains exposed to the flanking, direct, and vertical fires that fall on him. This mode of defence, which is recommended by several military men, particularly M. Vaultier, appears to me still better than that of lighting a fire at the foot of the breach, because it is more difficult for the besieged to feed, and more easily extinguished by the besieger, than when made in a ditch at the top of the breach. The other, however, has several times been employed with success."

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RECAPITULATION OF THE USE OF ARTILLERY IN THE DEFENCE.

Before the trenches are opened, the greatest possible number of pieces must be placed on the front of attack, as well in positions prepared for that purpose, as on the terraplain, to fire over the parapet with small charges, and plunge into the enemy's works.

The parks must be fired at, if within reach, but not until they are fairly established; as must the depots of fascines, which are never beyond the range of cannon; they are places where continual movements are carried on, particularly at the break and close of the day, at which times the workmen and the guards of the trenches assemble.

At the commencement of the siege, the ground of the attacks must be lighted up at night by shells filled with fire-works; during the next period, by carcasses, which can be thrown from 12 inch mortars more than 400 yards; and at the third parallel with fire-balls. When the enemy approaches the covered way, the same purpose will be served by pitched fascines placed on the glacis, and rampart lanthorns must be added, when he wishes to lodge himself in the covered way, or on the works.

At the time of opening the trenches, fire ricochets with small charges, crossing upon the work. Fire grenades also, from the outworks.

Fire ricochets, and point blank both directly and diagonally on the enemy's batteries, as soon as the place chosen for them is known. Fire also upon the head of the saps so as to compel the besieger to advance during the night only. To prevent him from advancing by the flying sap when it is dark, he must be lighted by numerous carcasses, and assailed by a violent fire of round shot and grenades.

Do not scatter your fire, but overpower first one battery, then attack the others in succession; do not fire upon the trenches that are finished, because that would waste ammunition uselessly.

Ricochet fires must be made great use of; they do much more damage than point blank fires, and often pass over the parapet into the interior of the trenches, which the direct fire cannot do. In this way, too, a fire may be continued by night as well as by day, over the advanced works, without any fear of incommoding the troops in the covered way and other outworks, by the wind of

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the balls, even when the batteries have little or no command. This fire, too, consumes much less powder.

In those works, that are much exposed to the fire of the enemy, keep no more than a single gun beside each traverse, and even shut up the embrasure with gabions and earth, sloping inwards so as to allow curved fires over it. Place the other pieces in the positions that are least exposed, and after a time carry them back to those they at first occupied. In this way the guns must be placed and displaced as circumstances may require, so that they may be exposed as short a time as possible to the batteries of the enemy. When this is done he cannot get at your guns, nay, will believe he has silenced them, and so advance and expose himself. If these precautions be not taken, the besieged loses his artillery, piece after piece, and finally has none at the very time he most needs it. (*Gassendi.*)

The large mortars must be served with spirit, but without scattering their fire. I again repeat, that by attempting to batter every thing, nothing is battered effectually. For example, bring 10 or 12 mortars to bear upon a troublesome battery, each of these will throw 30 shells in 10 or 12 hours; and if they are well directed, the battery attacked at the same time by such a shower of shells, the direct fire of some guns, and the ricochets of many more, cannot be maintained. When it is silenced, another is overwhelmed, and so on.

Mortars may be placed in any position where their distance from the points to be battered is not too great. The nearer they are to these points, the more true will be their fire; the more they are dispersed and separated from the other pieces, the more the enemy is compelled to scatter his fire. Their mode of firing permits them to be placed in many different positions; in the bastions attacked, and the collateral ones, on the angles of the shoulders, on the flank, and upon the curtains.

The small mortars should fire especially on the communications of the parallels, and the approaches by sap; they may be placed in the most advanced works, because they can be easily withdrawn.

Fire howitzes along the prolongation of the capitals, so as to enfilade the approaches, and also upon the batteries to make small mines.

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Stone mortars cannot be used at a greater distance than 150 yards; up to this time they are only employed to throw carcasses or fire-balls.

The guns and the ammunition must be used with economy and prudence during the two first periods of the siege, and reserved for the third, which is the epoch of the greatest action of the artillery. But if there be a battery or lodgment that is very troublesome, the whole of the fire should be directed upon it, to destroy it as soon as possible. If there is nothing of this kind, a moderate fire, governed by the progress of the attacks, batteries, and approaches, must be kept up, to compel the enemy to construct them solidly, and to neglect no precaution for his safety; this will cause him much delay, and will also prevent him from abridging his labours without exposing too many men to certain destruction. For this purpose, it is only necessary to cannonade him when he becomes negligent, and proceeds too fast. In the progress of the siege, the besieger loses his original advantages, and the besieged, for a time, may regain the ascendancy. This happens when he is on the glacis, and wishes to crown the covered way to establish his breach, and counter-batteries. At this time, it should be in the power of the besieged to oppose him with a violent fire, capable, if possible, of stopping him altogether, or if not, of delaying him, and making him pay dear for his successes.

Sorties must be protected by the fire of the place, either before or during the action, and to cover the retreat. The troops should carry small field pieces with them, to take the besieger and his trenches in reverse, and be accompanied by labourers carrying a shell between every two, charged, and provided with a fuse, if it be intended to destroy the batteries. These shells may be fired, after having placed them between the flasks of the besiegers guns, and will, by their bursting, break the carriages into pieces. In addition, the tools for spiking them must be carried along; the best for this purpose is a six sided nail, whose edges are cut into teeth by incisions oblique to the axis. (See vol. 1.)

The repairs of the batteries should be made as soon as they are needed, and they must not be permitted to be choked up by broken pieces of the carriages.

The commander of the artillery ought to visit the batteries:

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In the morning, to reconnoitre the besiegers works, and point out the places to be battered;

In the evening, to see the ammunition, consumed during the day, replaced;

At night, to light up the works of the besieger, and to cause the batteries to fire on those that are only just commenced.

He ought to endeavour to shelter his artillery from the overwhelming fire of the enemy at an early period, for on this, in a great measure, depends the defence of the place; he ought to husband his means, and preserve a great part of them for the near defence. He ought, from the beginning, to calculate the effects of his weapon, and combine the operations of it in such a manner, that a long and vigorous defence may be the result.

He ought to lay in a good supply of saucissons, gabions, pickets, and large timber before the investment, to collect earth in the works exposed to attack, in order to construct traverses and repair the epaulments. He should see to the preparation of wood for the platforms and small magazines, and for remounting his batteries; lay in a stock of iron, steel, paper for portfires, intrenching tools, &c. He should establish platforms, and revetments, at least as high as the *genouilliere*, in those places they may possibly be needed, in order that the artillery may be placed in a short time after the opening of the trenches. The labour in preparing the wood, gabions and saucissons for batteries, that may not be used, is not lost; for they may be afterwards employed in the repair of the others. He must press the manufacture of infantry cartridges, portfires, fire-balls, carcasses, pitched fascines, and rampart lights, of baskets and planks for charging stone mortars; and must see the fuses for the hollow projectiles prepared, and that part of those projectiles are loaded. If there be not enough of powder, he must have it made, for which purpose he will collect all the saltpetre in the town, or procure more from earth charged with nitre. He must shelter from the fire of shells, first, the ordnance laboratory, then the spare gun carriages, the armourers shops, and those of the smiths and wheelwrights who are employed on the repairs. If this cannot be done, he must place all these establishments in the least exposed parts.

As soon as the front of attack is known, he must direct his whole attention to the batteries and the placing of the guns, and he may

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complete this in the space of a day, if he has foreseen the enemy's projects, and provided all that is necessary. He must also establish small magazines under the rampart of the works, and near the batteries, for their daily service. (Those established near the points of attack for the use of the infantry are prepared by the engineers.)

The commander of the artillery must also secure good communications for the artillery from the place to the outworks, and must be satisfied of the solidity and extent of the magazines. The latter should be well closed and isolated from all dwellings, to prevent theft or communication of fire; they should be easy of access, and dry as well as bomb proof, for the safety of the powder, fireworks, match, and cordage. He must also examine if the supply of artillery stores is such as it ought to be, to assure a good defence.

He must frame a system for the care of the magazines under the charge of trusty keepers, who are usually corporals, or other non-commissioned officers; and dispose every thing in such a way as to render the distribution to the batteries easy. The contents of the magazines must not be made known, either before or during a siege, for fear a deserter might communicate an account to the enemy; who might thus be induced, if the ammunition be nearly expended, to continue a siege, in which a firm resistance, and the approach of an inclement season, had deprived him of all hope of success.

In fine, he must divide his service into proper departments, and place faithful officers at the head of each.

The defence admits of many other details into which we cannot now enter, and requires dispositions that must arise out of circumstances. These must be trusted to the experience of the artillery officer, and the knowledge he possesses of the management of his arm.

For an estimate of the duration of a siege, see the *Journal of the Defence*, which we shall give in the subsequent pages.

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JOURNAL OF THE ATTACK AND DEFENCE OF A FORTRESS.

The following journal, which is chiefly extracted from the work of Bousmard, will give, day by day, and night by night, a general view of the labours of the attack and defence, and show the minimum of the duration of a siege.

We suppose that the besieger has men enough to push his works as rapidly as possible, that there is only one *enceinte* preceded by half-moons, without detached or advanced works, and that no part is countermined.

Investment.

ATTACK.	DEFENCE.
The corps that is to execute the investment, arrives before the place, dislodges the advanced guards that the garrison may have posted in the neighbourhood, and on the principal avenues, and cuts off their retreat, if possible. It establishes, immediately, a double chain of posts, one of which looks towards the country, to prevent the arrival of succour, the other towards the place, to watch every thing that may attempt to leave it, and prevent any body from escaping to give information of its situation.	The garrison, the moment it hears of the enemy's approach, supports its outposts, and reinforces those which, if maintained, would impede the investment. If this cannot be done, it secures them a retreat, or withdraws them into the place before the enemy can intercept them.
The investment being formed, the ground is reconnoitred to choose the	The besieged, whose barbets are armed with cannon, makes use of

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position of the camp, and of the lines of counter and circumvallation, (pl. 6.) and it is attempted to reconnoitre the place so closely as to be able to choose the point of attack, and place the Park of Artillery as near it as possible.

The besieging army arrives soon after the investment is made, takes up the camp that has been reconnoitred for it, surrounding the place in a form nearly circular, and begins according to circumstances, to work upon the lines of circum and counter vallation, or those of circumvallation only, or on a few partial intrenchments. The country people are called upon to aid in these labours. If lines are made, this operation may occupy a space of nine days.

During the nine days employed on the lines, the besieger puts his park of artillery in order, as the several parts of it arrive; and has all the saucissons, fascines, gabions, pickets, &c. made, that are necessary for the erection of the works of the attack.

When every thing needed, both for the works and the artillery of the attacks is provided, the trenches are opened.

DEFENCE.

them to keep the investment and reconnoitring parties at a distance, but not with such charges as to show their full range. By this, the enemy may be so deceived, as to the distance, that he may establish his camp and lines too near, and be afterwards compelled to withdraw them.

During this time, small detachments are kept without the place, to oppose the reconnoitring parties. Shells loaded with fire-works, and carcasses, are thrown every night, particularly during the first hours, to the distance of 6 or 700 yards, all around the place; these show the opening of the trenches, so that no time may be lost in commencing the warmest possible fire on it, the moment it is discovered.

The besieged employs these nine days, in putting his parapets, banquets, and palisades in order; in disposing all the materials for his batteries in such a way that they may be erected the moment the proper time arrives; in preparing wood for the communications with the outworks, so that they may be established as soon as those that will be attacked are known.

First Night.

The besieger digs the whole of the first parallel at about 600 yards from the covered way, and forms the communication to the depots in rear of it. When day comes, the troops who have covered this parallel, shelter themselves in it, and it is finished by the labourers of the day who relieve those of the night. The points where the prolongations of the works to be battered

The besieged fires as many rounds as possible, from all the batteries and mortars that can be brought to bear on this work. He increases the amount of this fire by bringing to the front of attack all the disposable pieces. He may also attempt to make little sorties of light cavalry, to drive away and harass the workmen.

By day the besieged makes bridges

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cut this parallel, are marked. The batteries themselves are commenced at daybreak, if they are to be in the parallel; but if they are not in it, their erection cannot be begun until the following night.

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of communication to such of the outworks surrounded by water as have an action on the attack, the place of which is by this time known. He also labours to place his cannon in battery on these works, and on the body of the place, and begins traverses to guard all the faces of the work which he sees embraced by the parallel, against the ricochet.

If exterior works, such as fleches and counter-approaches, are to be made, he must lose no time in commencing them; and must also begin to construct the reducts, or tambours of the salient places of arms of the front of attack.

In these he must place howitzers, and small mortars mounted on gun-carriages, to fire ricochets along the capitals. He must also place guns of small caliber in the salient places of arms of the collateral fronts, to fire diagonally on the works of the besieger. At night fall the fire may be augmented, if the work of the more important batteries have been pushed forward.

Second Night.

The besieger begins to make his batteries, if he have not already done so, as mentioned above, and works upon the trenches of communication in front of the first parallel.

The same work is continued through the day.

The besieged finishes his batteries, without ceasing to keep up his fire, and make little sallies to disturb and retard the works. He busies himself with his counter approaches, and the traverses on his rampart.

Third Night.

The besieger pushes forward the approaches of the former night, continues the construction of the batteries, to which he brings gunpowder and cannon, under cover of the night.

The besieged continues to fire numerous ricochets along the capitals where he is sure to find both labourers and troops. The balls fired in this way, which may have failed to strike the

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The next day he finishes such of these batteries as are still behind, but waits until they are all finished before he begins to fire. They are at last unmasked, and all fired together. The first object is to ascertain, before it becomes dark, the proper charge and elevation for each of the guns; their aim must also be fixed, in order that their fire may be as correct by night as in the day.

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first zigzag, will probably fall into some other, into the parallel, or into the communications in the rear. A warm fire is kept up on the besieger's batteries, to which he at that moment is probably bringing cannon and gunpowder, with guns, and more especially with mortars. The besieged has probably finished his labours, and is very much advanced in the work of the fleches; he may now begin to work upon the retrenchments of the re-entering places of arms of the fronts of attack, as well as the inner retrenchments of the half-moon and the bastions. The next day he has the same objects to attain, the same conduct to observe, the same fire to keep up, the same work to perform.

Fourth Night.

This night may be the most favourable for the establishment of the second parallel. The besieged is still unaccustomed to the effect of the ricochet, and is employed especially in contriving means to preserve himself from it. The musketry fire in particular must be disturbed and deranged by it.

But if his artillery keeps up a warm fire with fixed cartridges, it will be better to wait until the ricochet has produced some effect upon it, before the second parallel is commenced. I suppose this to be the case, and that this operation is postponed until the next day.

The besieged keeps the position of the besieger continually lighted up; and if he attempt to open the second parallel, interrupts him in it, or makes that undertaking as deadly as possible by a fire of musketry from his covered way, and artillery from his works.

By day he keeps a fire against all the batteries, both of cannon aimed directly, and mortars, and fires ricochets upon the approaches.

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Fifth Night.

ATTACK.	DEFENCE.
The besieger begins his second parallel. And finishes it the next day, marking the place of those batteries that have not been completed in the first parallel, or are so placed that they must be removed into the second.	The besieged keeps up a fire of musketry from his covered way, and of artillery from his works. A great sortie is made before the day breaks. The work on the retrenchments, and in the covered way, is continued day and night.

Sixth Night.

The besieger opens zigzags from his second parallel, which he carries within 160 yards of the covered way. They are finished in the day time.	Ricochet and direct fires along the capitals, musketry from the covered way; fire of mortars and cannon against the batteries of the besieger; sorties. The labours on the retrenchments are continued day and night.

Seventh Night.

The besieger makes half places of arms upon the capitals, at the distance of 150 yards from the crest of the covered way. These are so far extended as to enfilade the branches of the covered way. These half places of arms are finished during the day, and batteries of mortars and howitzers, to rake the covered way, begun in them.	The besieged continues the fire of musketry from his covered way; ricochet and direct fires along the capitals; of mortars and guns with full charges upon the batteries of the besiegers. He makes sorties in strength to interrupt the work of the half places of arms. By day he keeps up the same fires.

Eighth Night.

Approaches are carried forward from the half place of arms by the sap proper, double, and direct. The howitzer batteries are finished,—the pieces and ammunition brought. They are opened during the day, and the saps carried on as fast as the cannon of the place will permit.	Fires as usual, and small sorties. The fire of the day is principally directed against the head of the saps.

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Ninth Night.

ATTACK.	DEFENCE.
The saps are pushed forward and terminated in portions of the third parallel. These portions of the parallel are continued at intervals during the day.	The usual fire and sorties. In the day time the fire is confined to the head of the saps, to prevent them from advancing.

Tenth Night.

The saps of the third parallel are carried on.

In the day it is finished, and batteries of mortars and stone mortars established in it against the covered way, and the re-entering places of arms.

Howitzers are sometimes placed in it to enfilade the branches of the covered way, the faces of the half-moons, &c.

The besieged endeavours this night, by his fire and sorties, to prevent the completion of the third parallel.

By day he cannonades the head of the saps, and the unfinished portions of the parallel. He prepares himself from this moment to oppose the storming of the covered way.

Eleventh Night.

Circular portions are made in front of the third parallel upon all the capitals, and double and direct saps are opened from it.

The batteries of mortars and stone mortars are finished.

They open their fire in the day time, and the sap is carried forward under favour of the fire of the third parallel.

A fire is made from all the artillery and musketry, that has been preserved, upon the head of the saps, without ceasing to be prepared to meet and repulse the attack of the covered way by storm.

Twelfth Night.

Trench cavaliers are made, by the sap, on the three capitals. They are also made in front of the re-entering places of arms, if the figure of the fortress requires approaches to be made nearer to them than the third parallel will admit.

The trench cavaliers are finished and raised higher during the day.

Every piece that can be brought to bear is discharged as often as possible, both day and night, against the work of the trench cavaliers; and every precaution is taken to prevent the lodgment on the covered way. The besiegers will probably do this by regular approaches, but every precaution against its storm must be taken.

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Thirteenth Night.

ATTACK.	DEFENCE.
The trench cavaliers are finished, and a double and direct sap is carried from them towards the salient angle of the covered way, to begin the lodgment on the crest of the glacis. Saps are carried from the third parallel along the capitals of the re-entering places of arms, if trench cavaliers have not already been made there. Stone mortars are placed in the trench cavaliers. The work of the lodgment or crowning is continued during the day.	Musketry is fired from the covered way, stone mortars from the reducts of the re-entering places of arms, and all the artillery that can bear on the attack.

Fourteenth Night.

The crowning of the three capitals is carried on, and batteries are commenced in it to counter-batter the flanks of the bastions, and the part of their faces opposite the ditch of the half-moon; together with batteries in breach against the faces of the half-moon. The work upon these is continued throughout the day.	Musketry and artillery fires on the labours of all the batteries, and on all the works that are not finished, and where the besieger still continues to move the earth. Sorties if the works can be destroyed by them. By day a fire is kept up from all the works.

Fifteenth Night.

These batteries are continued. The descents of the ditch are begun. The same works are carried on and improved during the day.	Fire against all the works. If the descent of the ditch is commenced, direct upon it shells, howitzes, and grenades.

Sixteenth Night.

The batteries are finished, their guns and ammunition brought into them. The descents of the ditch continued. When it is day the batteries open their fire, to silence that of the place, and make a breach in the half-moon.	As before; and if the place where the descent of the ditch is opened, be well known, a battery is prepared to batter the work of the passage.

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Seventeenth Night.

ATTACK.	DEFENCE.
The half-moon is battered in breach, and the descent of the ditch continued. As soon as it reaches the counterscarp the passage is begun. The same work goes on by day.	The artillery is withdrawn from the faces of the half-moon, part of it is placed on the curtain, to fire upon the flanked angle of the half-moon, when the besieger attempts to storm and form a lodgment on it. The stone mortars are placed in the reduct and behind the curtain. Every thing else goes on as in the former nights.

Eighteenth Night.

The besieger continues furiously, battering the half-moon in breach, and finishes the passage of the ditch. As soon as the breach is practicable, it is stormed, and crowned by a lodgment of gabions to compel the besieged to retire into the sections, towards which a sap is advanced along the parapets.

Shafts of mines are immediately opened in the lodgment that crowns the breach, which descend behind the counterscarp to blow it up, and open, afterwards, a large gap, through which the batteries on the crest of the glacis may make a breach in the reduct. Stone mortars are directed against the reduct of the half-moon and the sections.

The batteries on the crest of the glacis open breaches in the faces of the bastions, opposite the ditch of the half-moon, if it be intended to make the breach in this place.

All these works go on by day. If the half-moon, and the re-entering places of arms, have no reducts faced with masonry, the bastions and half-moon may be battered in breach, and stormed at the same time.

Preparations must be made to fire from the reducts and sections upon the salient angle of the half-moon, as soon as the enemy shows himself upon the breach. The fire of such parts of the curtain as see it, are also directed thither.

Fire in the day time upon the new saps, and batter the parapets furiously with ball, when the enemy approaches, in order to destroy them. The workmen are disturbed by musketry and grenades, or attacked, and their work overturned.

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Nineteenth Night.

ATTACK.	DEFENCE.
The besieger still batters the bastions in breach, and establishes batteries of stone mortars against the reduct and the sections. These are mounted and used. The mines, to overturn the counterscarp into the ditch of the reduct, are continued. The same work goes on in the day time.	The besieged keeps up a fire night and day, upon the work of the besieger.

Twentieth Night.

The besieger loads the mines of the half-moon, batters the bastions in breach, and carries a zigzag sap along the bottom of the ditch of the half-moon, from the passage of the ditch towards the breaches. When it is day he springs his mines, that overturn the counterscarp into the ditch of the reduct, and immediately after batters the reduct in breach, from the batteries on the glacis of the half-moon.	As the nineteenth night.

Twenty-first Night.

The reduct is still battered in breach, and the passage of its ditch carried on. This fire and work is continued during the day.	Every thing is prepared in the reduct of the half-moon, to receive the assault, and to make a resistance, that will compel the besieger to attack it in force. Vigorous and continual fires on the besieger's works, are kept up as before.

Twenty-second Night.

The besieger completes the passage of the ditch and the breaches of the reduct; he gives the assault, and crowns the breach with a lodgment, whence he pushes two saps towards	The infantry oppose the lodgment, inch by inch, by fires of musketry, showers of grenades, and sorties. By day the musketry, cannon, and stone mortars, of the retrenchments

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ATTACK.	DEFENCE.
the retrenchment, along the faces of the reduct.	and sections, fire upon the new lodgments, and the approaches along the faces of the half-moons and reducts.
As soon as the fire from these shall compel the besieged to abandon the sections of the faces of the half-moon, the besieger will lodge himself there, and push, along the face, a sap that will compel the besieged to abandon the reducts of the re-entering places of arms.	
(If the faces of the bastions are not breached opposite the ditch of the half-moon, by the batteries that crown its covered way; batteries in breach are established on the crown of their covered way, and in the re-entering places of arms.)	
Stone and grenade mortars are placed in the lodgment on the breach of the reduct of the half-moon, to harass the retrenchment. While these works are pressed forward, both night and day, the zigzags that lead along the ditches of the half-moon to the breaches of the bastions, are continued. The fires of all kinds are increased.	

Twenty-third Night.

The counterscarps of the reducts and retrenchments are crowned, and small guns and howitzers placed to destroy the fraises.	The besieged prepares himself to meet the assault on the retrenchment of the reduct, making the greatest possible fire of musketry, and throwing quantities of grenades on the assailants. When he sees them in force, and ready to carry the retrenchment, he retires quickly, to allow the fire from the curtain to act; unless he think it best to await the assault.
A lodgment is made as early as possible at the foot of the slope of the parapet, and so arranged as to receive the pieces intended to counter-batter the guns on the curtain.	
The reducts of the re-entering places of arms are siezed, either by forcing open the posterns, or by throwing small bridges across their ditch.	The besieged may expect the body of the place to be assaulted at the same time as the retrenchment of the reduct, and must prepare himself for that also.
If it be found necessary, some pieces of medium caliber are established in	

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ATTACK.	DEFENCE.
the reducts of the re-entering places of arms, to enlarge the breach of the bastion, and counter-batter the artillery of the curtain.	
The zigzags that lead to the breaches of the bastions, are pushed to the end of the ditch of the half-moon. But if the assault is to be given to the bastions near their flanked angles, the batteries mentioned in the last night, that are to breach them, and the descents of the ditch, must be hurried on.	

Twenty-fourth Night.

The epaulments of the passage of the ditch, are begun and extended till they meet the foot of the breach of the bastions.	The opening from the descent of the ditch and the epaulment of the passage, are cannonaded to delay their construction. They are also attacked by sorties along the ditch, if dry.
The fire from the breach and counter-batteries is kept up. Those in the interior of the reduct of the half-moon that are to act against the curtain, and those in the re-entering places of arms, (if needed,) are continued.	The besieged prepares either to await the assault and repulse it by force, or else to retire into his retrenchments after having opposed and delayed the lodgment of the besieger on the breach and rendered it bloody.
In the day these last batteries are finished.	

Twenty-fifth Night.

Guns and ammunition are brought into these batteries, and their fire opened, in conjunction with whatever other guns can protect the passages of the ditch of the body of the place. These passages are finished to the bottom of the breach, which is smoothed, to make it easy for the troops mounting to the assault.	The same labours and preparations as during the last.

Twenty-sixth Night.

The besieger reconnoitres the top of the breaches; if they are not retrenched, he gives the assault at day break,	If the besieged resolve to await the assault, he makes his dispositions for that purpose, in the way we have de-

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ATTACK.

and if he succeed, the place is carried on the twenty-sixth day after the opening of the trenches.

But if there be a retrenchment behind the breaches of the bastions, as is shown in plate 8, the besieger attempts nothing more than a lodgment on the top of the breach, and carries thither mortars and stone mortars to batter the retrenchment.

During the day he completes his work, and maintains a warm fire.

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scribed when treating of the defence.

The laws of war make it a duty to sustain the assault; the besieged must, therefore, make a retrenchment in the rear of the breach, to retire to after the assault. In this case, he opposes the lodgment of the besieger by a fire from the retrenchment, and quantities of shells, grenades, and stones.

Twenty-seventh Night.

The besieger opens a sap from his lodgment, in the manner of a parallel to the retrenchment, and places cannon in it to oppose that on the retrenchment. He also carries a sap along the parapet of the bastion to fire down upon the covered way of the retrenchment and support his small parallel, where he is at work upon batteries that are to silence the fire of the retrenchment. When they are ready, he prepares to mount their guns and bring up ammunition.

By day he completes the little parallel, continues the work on the batteries, and carries on the sap in the parapet.

He fires upon the retrenchment from all the batteries that can reach it.

A heavy fire is directed upon the works of the besieger, and sorties made to render the opening of his sap dangerous, if not impossible.

The besieged must profit by the momentary superiority he possesses over the besieger, who has not yet any guns mounted, and is in a very confined position.

Shells, grenades, and stones, are thrown upon the breach, over which every thing needed by the besieger in his lodgments, must pass. The flank of the collateral bastion cannonades the foot of the breach.

Twenty-eighth Night.

The batteries of the little parallel are finished, and their guns and ammunition brought up, if possible, the same night.

A double sap is directed from the parallel, straight upon the capital of the place of arms of the retrenchment, so

The fire upon the enemy's work is redoubled, whenever any movement is perceived that indicates the advance of his artillery.

Grenades are thrown upon the sappers who work upon the crown.

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ATTACK.	DEFENCE.
as to crown it. The saps in the parapet are continued, in order to aid this one by their fire upon its flanks, and compel the besieged to abandon the branches of the covered way. In the day the batteries, that are finished, fire; and others are erected. Preparations are made to effect a lodgment in the crown, which is now in forwardness.	

Twenty-ninth Night.

The crown of the covered way of the retrenchment is continued, taking care to leave gaps in it through which the guns of the small parallel may act, until it is itself in readiness to receive cannon. By day batteries are undertaken in the crown, and the other works are continued.	The besieged employs his artillery and musketry, which have now the superiority, in opposing the works upon the crown and its batteries, and renders the labour bloody.

Thirtieth Night.

The batteries upon the crown are armed with a part of the pieces of the parallel, which are replaced by mortars and stone mortars. The gap in the crown is closed and batteries established. The descent of the ditch of the retrenchment is begun.	The besieged does as during the preceding night.

Thirty-first Night.

The new batteries on the crown are armed with the rest of the pieces from the parallel, and mortars and stone mortars brought up to replace them and fire into the retrenchment. In the day time the retrenchment is battered, and the descent of the ditch continued.	Still the same for the besieged.

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Thirty-second Night.

ATTACK.	DEFENCE.
The passage of the ditch is made, and the battering in breach continued, or miners work upon the scarp of the retrenchment to open a passage.	The greatest possible fire is kept up, and means sought to interrupt the passage of the ditch.

Thirty-Third Night.

A breach having been made in the retrenchment, it is stormed.	The breach being practicable, the besieged will await the assault if he has another retrenchment in his rear, or any other sure retreat, such as houses with loop-holes, or barricades, to which he may retire if the besieger is successful.

By this journal it may be seen, that when the besieger advances with the utmost rapidity, and the defence is only methodical and according to the calculation of the *minimum*, and not the *maximum*, of defence,* a fortress may hold out at least 33 days after the trenches are opened.

INCREASE OF THE LENGTH OF THE SIEGE.

The length of a siege may be easily increased 18 days, without supposing that the besieged is often able to destroy the lodgments of the besieger, after the establishment of the third parallel;—that he retakes the covered ways, the half-moon, and its reducts, several times; or that he disputes the attack in the most violent manner.

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* The minimum of defence supposes that the place is defended by missiles alone, that no sorties are made to destroy the work of the besieger, the ground abandoned to him in proportion as he advances, and no acts of vigour performed. Sixty days is not too much to allow for the duration of a siege, since Dantzic, when besieged by the French in 1807, held out 54 days after the trenches were opened, and was surrendered before the storm of the outworks, and while the body of the place was still left behind them.

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These additional days, that may reasonably be calculated, are as follows, viz.

3 days for the establishment of the third parallel, and taking the covered way.

2 do. for taking the faces of the half-moon, and forming lodgments on it.

2 do. for taking the reduct and its retrenchment.

11 do. for the delay the besieged may cause by only such mines as he can make during the siege.

The place then will hold out 51 days after the trenches are opened, and if 9 days be allowed for the investment, the whole duration of the siege will be sixty days.

We shall see hereafter, when we notice some of the most famous sieges, how far the time of resistance may be increased. The governor of a place ought to extend its defence to the greatest possible degree. He ought to recollect unceasingly, that, independently of military glory, which should induce him to make a brilliant defence, the surrender of the place a single day too soon, may cause the most disastrous consequences to the operations of the army of his country, and in arranging the terms of a treaty of peace.

Note. If the fronts of a fortification were constructed upon a polygon of such a number of sides, (a decagon for example,) that two adjacent fronts are nearly in the same straight line, instead of making a much smaller angle, as in plate 8; it would then be necessary to attack two half-moons in order to reach the intermediate bastion. This would augment the labours of the siege a little, but would not much increase its duration.

In the preceding journal it has been supposed, that there was no detached work or advanced covered way, but the addition of these, even if not countermined, will augment the resistance very much.

Simple arrows in front of the salient angle will hold out, - - - - - - - -	3 or	4 days.
Arrows with wooden tambours within them,	6	7
An advanced covered way with a single row of reducts, - - - - - -		9

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An advanced covered way with salient and re-entering reducts, - - - - - - 15 days.
A horn work in front of the glacis, - - - 12 or 14
A crown work, - - - - - - - 15 16

When these latter works open on the ditches of the half-moon, they do not add more than 6 days to the length of the siege.

In our journal we have supposed the means of defence by mines to be very limited; but a counter-mined glacis may retard the capture of the place 60, or even, according to *Bousmard*, 90 days, when the mines are extended to every part of the defences that is fitted to receive them, into the interior of the works, beneath a dry ditch, and under the lodgments on the breaches.

Of the Prolongation of the defence by means of Mines.

We cannot better show the importance of mines, than by extracting the relation given by *Bousmard* of the famous siege of Schweidnitz. During this siege, the miners of both parties made the most extraordinary efforts. The besieged were directed by the celebrated French General of Artillery, *Gribeauval*, and the besiegers by the engineer, *Lefèvre*.

"That I may not be accused of exaggeration, (says Bousmard,) and of giving the reins to my imagination, I shall give a journal of the subterranean attack of Schweidnitz, by the Prussians, in 1762. At this siege, globes of compression were used for the first time. We may judge from the circumstances and duration of this attack, on a place that had few counter-mines, and those for the most part constructed during the siege, how much a complete system of countermines will add to the strength of a place.

"The trenches of the Prussians being brought within 70 yards of the palisade, or crest of the covered way of the place, it was thought a proper time for the miners to begin their labours. This they did on the night of the 22d of August, and when they had sunk a shaft to the depth of 16 feet, they opened a gallery which, by the night of the 30th, was carried forwards 96 feet. The chamber of the mine was formed on the 31st, and the following night the powder carried to it. It was rammed the 1st of September, and fired the same evening at nine o'clock. The line of least resistance was 16 feet, it was charged with 5,000 pounds of

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powder, and made a crater 90 feet in diameter, which reached within 60 feet of the palisade. This crater was crowned on the 2d; and on the 3d the besiegers began a gallery, which they were compelled, by the water they met with, to abandon on the 8th, after having advanced 22 feet; it was 21 feet below the surface. Another was commenced that very day to the left of the first, and 9 feet nearer the surface, which had advanced 68 feet before 10 o'clock on the evening of the 9th. At this time the besieged sprung a fougass, which destroyed the middle of it for about 24 feet, and wounded 4 miners. The besiegers re-established it, and continued to push it forward. On the evening of the 10th, it was 72 feet long, but it then opened on one of the galleries of the place, and the miners were driven back by a fire of musketry. Immediately after, the besieged fired a mine on the right of the gallery, that destroyed 60 feet of it, or nearly the whole.

On the 11th of September, the besiegers opened a third gallery to the left of the second, which they endeavoured at the same time to repair, not knowing that it was almost totally destroyed. On the 12th, they met the crater of the besieged's mine, that had ruined it; and made a lodgment on its crown without going farther. The other gallery, on the left, was by this time 16 feet long; the besieged fired two mines, one after the other, to the right and left of it, that deranged some of the frames. These, however, were soon re-established. On the 15th, the gallery on the left was 42 feet long, but the besieger then fell in with an old gallery of the besieged, the stench in which was so great as to prevent his proceeding. A lodgment was made as soon as possible on this spot, beneath which, at the depth of 12 feet, 2,000 pounds of powder were found. The branch was then rammed to the distance of 36 feet from the chamber, which was fired on the 15th, at 5 in the morning, and made a crater 60 feet in diameter, which reached within 12 feet of the palisade. It, however, ruined the lodgment on the crater of the besieged's mine, as well as the communication with it, and of course compelled the besieger to abandon both. The besieger, however, immediately made a traverse in the new crater to cover those who guarded his miners. These then opened a branch, that was blown up on the 17th at 11 o'clock at night, when only 8 feet long, by a fougass of the besieged. On the 18th, two branches were opened from the same

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crater, one in the direction of the salient angle of the covered way, the other to the right of that angle. They were hardly begun when a fougass of the besieged ruined them both, at 4 o'clock the same day. The night of the 18th, the besieger undertook a new branch, which was overthrown in the same way on the 18th, when only 8 feet long. Another branch, re-commenced on the 19th, met with the same fate on the morning of the 20th.

The besieger finding the extreme difficulty of advancing, resolved to attempt a diversion; to attack the enemy on one side by fougasses, to draw off his attention, while he should open a gallery upon the other, and carry it forward, at the greatest possible depth, until he could establish a globe of compression at its extremity, to ruin the principal gallery of the besieged. He, therefore, opened on the 20th, without loss of time, the gallery and the branch intended to effect this purpose. This last was hardly 7 feet long, when it was destroyed by a fougass, at 8 o'clock in the evening of the 22d. The deep gallery happily received no damage from this, except so far as it became exposed to shells. These, by falling into the craters of the fougasses, broke into the gallery in several places, and retarded its progress very much by the repairs they rendered necessary. The gallery was only 20 feet long when the king descended into it on the morning of the 24th, and directed a return of 4 feet to be immediately made in it, and a chamber to lodge 3,000 pounds of powder. This was done, the powder placed hastily in sacks, without a box, and the gallery filled up with sand bags. This mine was 20 feet deep, and when fired at 10 o'clock on the morning of the same day, made a crater 60 feet in diameter, and reaching within 8 feet of the palisade.

"The besiegers formed two traverses in this, behind which they lodged a party of volunteers, under whose protection the miners began, on the 25th, to open two branches. At 8 o'clock, on the evening of the 26th, when one of the branches was 15 feet long, and the other 11, the besieged destroyed the latter by a fougass; the same night, at 1 o'clock, he first fired a fougass that destroyed the communication of the other branch, and then sallied out and possessed himself of both craters. He remained there all the rest of the night, and abandoned them in the day, after having cut away the remains of the glacis in such a way as to allow him to see

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into the very bottom of the crater of the last globe of compression. This prevented the besieger from establishing himself in it, and compelled him to make, on the 27th, a traverse in the crater of the second globe, from which he might proceed by a covered sap, to regain the ground he had been driven from. On the 28th and 29th, the miners carried this covered sap 23 feet forward, and, at the same time, carried another to the left, towards the last crater of the besieged.

"On the 2d of October, the work of the besieger being carried forward either by galleries or covered saps 4 feet, met a ruined gallery of the besieged's. On the 4th, it had proceeded 65 feet, when, at 6 o'clock in the evening, the besieged fired a fougass to the left of it, that did not do any damage. On the 5th and 6th, the gallery was 87 feet long, and on the 7th, the besieged again played off two mines against it, one at 8, the other at 11 o'clock at night. These fougasses being higher than it, and also too distant, did no harm.

On the 8th, when the gallery was 96 feet long, the besieger's miners made a chamber at its extremity, that was loaded with 5,000 pounds of powder. The gallery was rammed for the distance of 48 feet, and the mine fired at midnight. It opened the covered way entirely, and threw the counterscarp into the ditch; neither of these, it must be confessed, were very wide. A casemate filled with powder had exploded just before, in the gorge of the work attacked, and the besieged began to be in want of ammunition and provisions. All these circumstances combined, induced him to surrender on the 9th of October, 63 days after the opening of the trenches, and 48 after the beginning of the attack by mines.

OF SUDDEN AND IRREGULAR ATTACKS UPON FORTRESSES.

Strong places have sometimes been taken by surprise, or carried by main force. Such an event has hardly ever happened, except through the weakness or negligence of the garrison, or in consequence of some great fault in the fortification.

Places are surprised either by means of a secret understanding with persons within, who open a passage, or by breaking in at the gates, posterns, and acqueducts, by the petard and tools.

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The Petard, which is sometimes used to force open the gates of small towns, or castles, and even to break down their walls, is a sort of brass pot, cast very thick. It is filled with powder, and fired by means of a fuse. (See *Fireworks.*)

This petard is fastened upon a plank, in which there is a screw or bolt, that is driven into the wood of the gate that is to be forced. The attacking detachment is placed in ambush, as near the gate as possible, so that it may enter the moment the petard has done its duty. (A bomb may be substituted for a petard.)

A place cannot be taken in this way, except when there is no more than one gate to force, and when there are no outworks. The grating of sewers, and the hinges of posterns may likewise be forced by masons' or smiths' tools. But in this case, the number and nature of the obstacles must be known, and a petard provided to be used against the last of them.

A surprise by escalade is liable to fewer unforeseen difficulties than the last method. The greatest is that of reaching the ditch of the rampart to be attacked, in sufficient force. Even ladders are not needed when the rampart is of earth, particularly when it is not fraised. If it be fraised, ladders will be needed of a height sufficient to reach the fraise, or it may be cut with axes in the place where the rampart is to be ascended. Every part of the rampart liable to escalade should, if possible, be attacked; and the grates of acqueducts, sewers, and sluices, broken or demolished, at the same instant.

These attacks by main force can only succeed with places that have weak garrisons, and whose relief is not great enough to prevent the use of ladders; those whose fortification is of earth, and whose ditches are every where passable; where the service is ill performed, and there is no watchfulness.

"Fortifications ill adapted to the ground; irregularities of the ground that weaken the place; or a want of the means of defence, particularly of artillery, have sometimes allowed a breach to be made, and the assault given at once,* or permitted the omission of a great part of the labour of the approach. (*Bousmard*, vol. 3.)

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* At one of the sieges of Namur, a breach was made in the branch of a horn-work, by a battery established on the opposite side of the Meuse.

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PRACTICAL LESSONS FOR THE DEFENCE OF PLACES.

The abridged account we are about to give of the most famous sieges of ancient and modern times, is a series of practical lessons upon the art of defence, more useful than any theory. It is extracted from the work of General Carnot, on the Defence of Places;—it shows that fortresses may resist much longer than our theoretic journal would intimate, and furnishes means of estimating the maximum of a defence conducted with talent and firmness.

SIEGE OF ALESIA,* BY JULIUS CÆSAR.

52 years before Christ.

We shall extract, almost entire, the relation that Cæsar himself gives of this famous siege; because the enormous works this illustrious general made, around the place, are often cited by military authors; and because, as Carnot says, "This relation is, of itself, an excellent treatise on the attack and defence of places. In it are to be found examples of almost every thing that is practised at the present day, with only those modifications produced by the change of arms; together with every act of diligence, bravery, and industry, that can be expected from two nations combatting under the most celebrated generals of their age, the one fighting for Glory, the other for Liberty."

* Alesia, an ancient city of Celtic Gaul, is at the present day nothing more than a village of Burgundy, on Mount Auxois, called Sainte Reine.

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"Vercingetorix, (commander-in-chief of the Gauls,) seeing all his cavalry routed, (at the end of a battle won by Cæsar,) retreated to Alesia. Cæsar pursued him as long as it was light. The next morning he sat down before Alesia, and immediately commenced lines of circum and countervallation* around the city.

"Alesia was situated upon the top of a lofty hill, so that it appeared to him that it could not be reduced except by a formal siege. At the foot of this hill there ran two streams, one on each side of the town. In front of it was a plain, three miles in length, but on all the other sides it was surrounded by hills at a short distance from, and as high as the ground itself occupied. The Gauls encamped on the eastern side at the foot of the walls, and occupied the whole bank in that direction. They were covered by a ditch and a dry stone wall, 6 feet in height. The line of countervallation of the Romans, was eleven miles in circuit. Their camp was advantageously situated; and defended by 23 redoubts, in which a strict guard was kept, throughout the day, to repulse sudden sorties; by night the number of troops in them was increased, and sentinels placed in every direction.

"While these works were constructing, a skirmish of cavalry took place in the plain, that, as we have already said, extended between the hills. Both sides fought with obstinacy, but the Gauls were finally compelled to retire to their intrenchments.

"Before the Romans finished their lines of countervallation, Vercingetorix resolved to send away all his cavalry by night. In dismissing them, he ordered that they should each retire into their own district, and return thence with all the inhabitants capable of bearing arms. He pointed out the services he had rendered, and conjured them not to leave a man, who had sacrificed every thing to the public good, to the mercy of his enemies. He told them he had bread for about a month, that it might last even longer by using it frugally, but that if they did not return within that time, they would leave to perish, himself and 80,000 chosen men. After he had said this, he dismissed his cavalry through a part where the lines were not finished. He directed that all the corn in the city should be brought him, under pain of death; of this, he

* See pl. 6. Lines of circumvallation and countervallation.

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established a regular but moderate ration; having a considerable quantity of cattle brought in by force from the territory of the Mandubii, he distributed meat more liberally; he then brought within the city all his forces who had encamped before the town. In this situation he resolved to await the aid of the Gauls, and to sustain the siege.

"Cæsar, who was acquainted with all these facts by prisoners and deserters, resolved to execute fortifications, of which the following is a description. A ditch, with perpendicular sides, was first dug of the width and depth of 20 feet; the remaining works were established 400 feet in rear of this; by this means he enclosed as much ground as was proper to keep him from being easily surrounded, and prevented the enemy from surprising the lines in force, and from disturbing the work by darts during the day. At this place he made two ditches of the breadth and depth of 15 feet, and filled the inner one, which was in the plain at the foot of the heights, with water from the river. Behind these he constructed a terraced rampart, 12 feet in height, furnished with a parapet and loop-holes, and surmounted with large forked trunks, (called stags,) to stop the enemy attempting to scale the fortification. The whole was flanked by towers 80 feet apart.

"The Romans were compelled to provide materials, collect provisions, and construct these enormous works, at one and the same time; to do all this, it was necessary to go to considerable distances, and thus the force in the camp was diminished; the Gauls, too, sometimes attempted to force our works, and sallied from several gates at a time in great force. On these accounts, Cæsar thought that additions must be made to his lines to make them defensible by a smaller number of troops. He, therefore, ordered trees, or stout limbs to be collected and sharpened at top; dug a ditch five feet deep, in front of his lines, placed these limbs in it with their ends in the ground, and tied them together to prevent their being drawn out. There were five rows of these tied together and interwoven, so that whoever entered the ditch was exposed to be impaled on the sharpened branches; these were called *Cippi*. In front of these, pits three feet in depth, were dug in a quincunx form, narrower at bottom than at top; in these were placed stakes as thick as a man's thigh, hardened in the fire and sharpened; they projected above the surface only the breadth of

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4 fingers; the mouths of these pits were concealed with vines and brush. There were eight rows of such pits three feet from each other, and they were called *lillies* by the soldiers, from their resemblance to that flower. Still in front of these Cæsar planted in the earth pickets of wood a foot in length with sharp iron points; these were set at small distances from each other in every direction, and were called needles.

"When this was finished, he drew his line of circumvallation in the most level ground he could find; this was fourteen miles in length, and exactly similar to the other, so that no multitude of the enemy, however great, could entirely invest him.

"To prevent his troops from running any risk, by leaving their camp, he ordered them to provide provisions and forage for thirty days.

"While this was doing at Alesia, the states of the Gauls assembled, and resolved, instead of summoning all persons who could bear arms, as Vercingetorix advised, to call out a certain number from each nation; to avoid the risk of confusion, make the discipline more easy, and the supply of provisions less difficult. In consequence, 240,000 infantry, and 8,000 cavalry were completed according to the contingents; and Comius, Virdumarus, Eporedorix, and Virgesillaunus, (the cousin of Vercingetorix,) appointed to command them. To assist these with their counsel, deputies were sent by each nation. All set out for Alesia, and marched to its relief full of spirit and confidence; there was not one of them who thought that the Romans could withstand the very appearance of such an host, particularly as they would be attacked on both sides, by the besieged sallying from their walls, and by a numerous army of infantry and cavalry surrounding them from without.

"But the besieged, seeing their bread exhausted, and the day fixed for their relief passed, ignorant of what was doing in the council of the allied nations, assembled together to consult on the course the exigency of their affairs required them to pursue. In this council, opinions were much divided; one party advised a surrender, and another a vigorous sortie while they still retained strength for that purpose. Critognatus, a man of consequence, addressed them, and begged them not to give up their country to eternal slavery, by rash and weak resolutions. He represented to them, that the immense works of the Romans announced the ap-

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proach of relief; and had the boldness to make the execrable proposition, that they should rather feed upon the flesh of those whose age rendered them useless in the defence, than surrender; following in this the example of their ancestors in their war with the Cimbri and Teutones, a war less threatening to their liberties.

"When the vote was taken, it was found to be resolved, that the sick, the aged, the women, and the children, should leave the city, and that every extremity should be endured before agreeing to the proposal of Critognatus; but that it should be followed, if it became necessary, and the relief were delayed, rather than surrender. All the useless mouths were, therefore, expelled from the city, and approached the camp of the Romans with prayers and intreaties, but Cæsar placed guards to prevent their being admitted.

"At last, the army of the Gauls approached Alesia, and posted itself on a height not more than half a mile from the Roman lines. The next day the whole of their cavalry descended and filled the plain, described above as extending three miles; their infantry was kept hidden by the neighbouring heights. The town of Alesia, looked into the country in such a way as to see this succour. The besieged meet and congratulate each other on the relief; their troops sally out, form in order of battle before the town, fill up the nearest ditch with hurdles, and prepare themselves for trying the chances of a sortie.

"Cæsar having drawn up his army so as to line, both his works of circum and counter-vallation; that each person might know and take his particular post, sent out his cavalry to skirmish against the Gauls. Every thing that passed in the plain was seen from the camp, because it was upon the heights, and all the soldiers anxiously watched the issue of this skirmish. The Gauls had placed some archers and light armed infantry among their cavalry, to support it, if it should give way, and arrest the charge of the Romans. Several of the Roman cavalry were wounded by their missiles, and compelled to quit the field. The Gauls seeing the Romans pressed by their superior numbers, believed themselves sure of victory; and under this impression, the whole of them, both in the city and the relieving army, uttered loud cries of joy to encourage their comrades. As the two camps beheld all that passed, and neither brave nor cowardly conduct could be concealed, every person was animated to exertion by the desire of glory, and the dread of dis-

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grace. The action had lasted, without any decisive success on either part, from noon until sunset; at this time, Cæsar's German cavalry having broken the line of the Gauls, they were compelled to retire in every direction, and return to their camp. The besieged who had sallied from the town, returned to it sad and hopeless of success.

"The Gauls did not show themselves in the field for the whole of the following day, but employed themselves in preparing quantities of hurdles, ladders, forks, &c. Thus provided, they left their camp about midnight, and silently approached the line of circumvallation. Having reached it, they all at once set up a cry to inform the besieged of their attack; then, throwing in their hurdles, they overwhelmed the guards of the ramparts with darts, arrows, and stones, and made all their dispositions for assault. Vercingetorix being advised by their cries, of what was going forward, gives the signal on his part, and sallies from the town. The Romans run to their intrenchments, and take each the post that had been marked out to them the preceding day; they arrest the progress of the enemy with slings, arrows, beams, and balls of lead, and shower darts upon them from their machines. The Gauls, in approaching, were embarrassed and wounded by the *needles*, fell into the pits, and were empaled on the stakes, or perished under the showers of javelins cast upon them from the ramparts and towers. Many on both sides were wounded; but at last, when the day broke, and the intrenchments still remained unbroken, the Gauls retired, fearing that they might be charged in flank by a party sallying from the higher part of Cæsar's quarters. On the other side, the garrison making use of the materials Vercingetorix had prepared for the attack, filled up the ditches; but this operation detained them so long, that they perceived the retreat of their friends before they reached the intrenchments; they, therefore, returned to the city without attempting any thing besides.

"The Gauls being thus twice repulsed with loss, consult, in order to form a new plan. They examine persons acquainted with the ground, as to the situation and fortification of the higher part of the Roman camp, On the northern side, there was a hill that could not, on account of its extent, be inclosed in the lines; they were, in consequence, carried along the foot, and upon the slope of the hill, on disadvantageous ground. This part of the

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lines was guarded by two legions.* The Gauls being well informed of the nature of the ground, sent to this place 50,000 men, picked out of the troops of those nations whose reputation for bravery was the greatest. The command of this body was given to Virgesillaunus, and it was resolved to make the attack about noon. Virgesillaunus set out with his troops about 6 o'clock in the evening, and at daybreak had arrived within a short distance of the intrenchments. Here he hid himself behind the hill until the moment chosen for the attack; at noon he marches towards the quarter we have described above. The cavalry of the Gauls, at the same time, approaches the lines in the plain; and the remainder of their infantry forms in order of battle at the head of their camp. Vercingetorix, who beheld them from the summit of the citadel of Alesia, sallies out with his whole force, taking with him his long poles, his covered galleries, his scythes, and all the other apparatus he had prepared for the assault. The action is begun on all sides at the same instant, and the attacks directed upon the points most feeble in appearance. The Romans have such an extent of Fortification to guard, that their numbers hardly suffice to occupy the whole of it; while the cries of the enemy in their rear, contributed to inspire them with terror.

"Cæsar placed himself on a height whence he could see all that passed within his lines, and send reinforcements to those parts that were most threatened. The two armies feel that the decisive moment has arrived, and that they must make the most strenuous efforts. The Gauls are aware that their safety and liberty depend on their forcing the lines; the Romans, that victory will happily terminate all their fatigues. The Romans found the greatest difficulty in defending the part of the line against which Virgesillaunus was sent, as we have mentioned above, for the elevation of the exterior ground gave the Gauls a great advantage. One party of them throws darts, and another marches to the assault; fresh troops continually relieve those who are fatigued; they throw earth and fascines into the ditches, to enable them to cross, and they secure themselves from the pits in the same way. The Romans begin to

* The legion was a body of about 5,000 men, and was divided into 10 cohorts.

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want supplies, and their spirits fail. Cæsar sends to their assistance Labienus with six cohorts; he orders him to sally out if he fears he may be forced; but not to do so until the last extremity. He, himself, proceeds to encourage the rest, and exhort them not to cease from their exertions, representing to them that the hour was at hand when they were to reap the fruits of all their former combats.

"The garrison, hopeless of forcing the intrenchments in the plain on account of their height, attempt to scale the quarters on the hills, and carry thither all the means they had prepared for the assault. They dislodge those posted on the towers, by showers of darts; they make themselves passages by filling up the ditch with earth and fascines, and destroy the battlement of the rampart with scythes. Cæsar first sends a reinforcement of six cohorts to this place, afterwards seven more; and finding the combat grew still more desperate, he proceeds thither, with aid, himself; re-establishes order, and repulses the enemy; after this, he proceeds towards the place whither he had detached Labienus. In passing, he draws four cohorts from the nearest redoubts, orders a part of the cavalry to follow him, and directs the remainder to sally from the lines of circumvallation, and attack the Gauls in the rear. By this time, Labienus found that neither the rampart nor the ditches could restrain the enemy, and drew together, in consequence, the whole strength he could muster near him, amounting to 39 cohorts; then sent to inform Cæsar of the project he had in view. Cæsar hastened to be present at the action.

"He is immediately known by the colour of the dress he was accustomed to wear in battle. The Gauls, who, from the top of the hill, perceive him on its slope, accompanied by the squadrons and cohorts he had ordered to join him, rush to the attack. A great cry rises from the conflicting parties; the Romans throw their javelins, and then charge sword in hand; at this instant the cavalry appears in the rear of the Gauls; other cohorts advance; the Gauls turn their backs and are pursued by the enemy, who make a dreadful slaughter. The besieged, perceiving the carnage and the flight of their friends, lose all hope, and abandon the attack of the works. The next day the city surrendered." (*Cæsar's Commentaries*, Book vii.)

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SIEGE OF RHODES BY THE TURKS IN 1521.

"*Villiers de l'Isle Adam*, was at that time grand master of the Knights of St. John of Jerusalem, who held Rhodes; a great warrior, brave, intrepid, skilful, and full of resources. He had not more than six thousand troops to oppose an army of nearly 200,000 men. But these warriors were, like their commander, full of the most heroic valour, and preferred death to bondage. Rhodes was invested; the trenches were opened beyond the range of cannon; and when they were brought nearer to the place, the Turks established a battery, but it was soon dismounted by the artillery of the place. The frequent sorties of the knights destroyed the labours of the Turks; and in a short time their dismay became so great, that it became necessary that the Sultan should show himself in person to the troops, to animate their spirits by his presence. From this time every thing underwent a total change; all were anxious to be distinguished under the eye of their master; the soldiers pressed on the trenches night and day without cessation. The grand master perceiving that they were supported by strong detachments did not think proper to continue sorties, in which he lost more by the death of a single knight than Soliman by the destruction of fifty Janisaries. The Turks having no longer any thing to fear but the fire of the place, pushed their approaches to the very counterscarp; and to render their works more solid, lined them on the outside with posts and timbers strongly fastened together. This done, they erected two lofty cavaliers, ten or twelve feet higher than the walls of the city, and entirely commanding it. The gate of Germany was attacked first. The Turks directed their cannon against the wall which was not terraced. It was, therefore, hardly expected that it could long withstand their fire. The grand master visited the place in person, and caused it to be supported from within by earth, posts, and fascines. The artillery placed at the gate of his palace, upon lofty ground, bore directly upon the Turks, from thence the Christian gunners destroyed them, and threw down their parapets; those they rebuilt were served in the same way. The cannon of the town destroyed every thing; while that of the Turks, ill served, threw its shot over the wall, and fired at random. The batteries against the tower of St. Nicholas were treated in the

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same way, until, to prevent the effects of the Christian skill, the Turks resolved to fire only by night, and buried their guns, during the day, in the sand. This battery at last made a breach in the wall, and they flattered themselves they would carry the town at the first assault; but were much surprised to see a new wall and parapet, terraced, and lined with artillery to defend the approaches to it, appear from behind the ruins.

"However, the number of knights and citizens of Rhodes diminished rapidly, and powder grew scarce. The grand master caused more to be made from saltpetre, of which he had laid in a stock, and hoped to be able to make so long a resistance, as would compel the Sultan to raise the siege.

"Up to this time, the war had been carried on by fire-arms alone; the Turks had not taken a single inch of ground in the works; the retrenchments of the knights supplied the place of their ruined walls. Soliman caused earth and stones to be thrown into the ditch to fill it up and make a passage, but the besieged carried off at night through their casemates, the rubbish thrown into it during the day; he opened mines in five different places, some of these were drawn off, but two were sprung under the bastion of England; these overthrew 36 feet of the wall, the rubbish of which filled up the ditch. The breach was so large and the ascent to it so easy, that several battalions instantly rushed to the assault, sword in hand, and with loud cries. They quickly gained the top of the bastion, planted seven stand of colours upon it, and would have taken it had not they met a traverse that arrested their progress. By this time the knights had recovered from the astonishment into which the horrible noise of the mine had thrown them, and ran to the bastion, where they attacked the Turks with musketry, grenades, and stones.

"The grand master was, at the moment the mine sprung, in a neighbouring church, imploring, at the foot of the altar, the aid of the God of Battles. Judging from the noise he heard, that the bursting of the mine would be followed by an assault, he arose; at this moment, the priests, about to commence the service, chaunted the preliminary prayer; *Deus in adjutorium meum intende*, "Lord! arise, help and deliver me;" "*I accept the omen*," cried the pious general, and turning to the knights of his train, he said, "*Let us go, my dear brethren, and turn the sacrifice of our praise into that of our lives, and die, if it be necessary, for the defence of our holy*

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faith. Having said this, he advances, pike in hand, and with a threatening air mounts the bastion, attacks the Turks, drives out, overturns, and kills all who resist him; he siezes the standard of the enemy and regains the bastion. Soliman's general, *Mustapha*, rallies the fugitives, and with blows of the sabre, brings them once more to the breach, and marches boldly to it at their head. The combat is renewed, the strife becomes bloody; death is inflicted by each party on the other, with both edged and missile weapons; the sword and the musket are both used; at last, they grapple with one another, and the strongest or most active destroys his foe with the dagger. But the Turks, exposed to musketry, grenades, stones, and carcasses, finally abandon the breach, and turn their backs. Their general endeavours to restore their courage, both by threats and promises, but is no longer heard; all fly and disperse; Mustapha retires with them, after having lost more than 3,000 men.

"The victory was disputed with equal bloodshed until the 24th of September, when Soliman ordered a general assault. At break of day, the Turks advanced, from four sides, in four large bodies, or rather armies, and mounted the breach, in spite of the fire of the place, and the deluge of balls, arrows, darts, and stones, that showered upon them. But the knights run to meet them, repulse the assailants, and overturn their ladders. These again return to the attack; but all their efforts are useless; the knights are invincible, and priests, old men, monks, and even children, wish to have their share of the danger, and the honour of repulsing the enemy. The women did not yield to any of them in courage nor constancy, and several of them lost their lives in fighting in defence of their husbands and children.

"The bad success of all these attacks rendered Soliman furious; he caused Mustapha to be put to death by a shower of arrows. New combats and new attacks continued until the middle of the winter, when the Turks at last triumphed. Rhodes, nearly in ruins, had no longer any strength to oppose them. The greater part of its knights had died in its defence. It became, then, necessary to capitulate and abandon this famous island, that for nearly three centuries had been the habitation of a society of heroes.*

* In the year 1308, Foulques de Villaret, Grand Master of the Knights of St. John of Jerusalem, aided by the sovereigns of Europe, conquered Rhodes, and made it the chief seat of his order.

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Soliman used his victory with moderation; he treated the grand master with generosity, consoled him, and even visited him, and finally mourned for his death as his merit deserved.

SIEGE OF ANTWERP BY THE SPANIARDS, IN 1584.

"I undertake," says Strada, "to write the history of the most memorable siege that was ever conducted against any city. For never were rivers stopped by such labours; never did the human mind conceive more bold inventions; nor did ever troops, to whom the experience of many sieges had given skill and confidence, perform greater acts of valour. On this occasion, fortresses were built upon rapid rivers; mines constructed beneath the water; rivers carried over the top of their dykes; and new dykes constructed across rivers."

We shall only relate a few of the most remarkable actions of the siege, according to the recital of Carnot.

"The besiegers now undertook a work of the greatest difficulty: this was to close the passage of the Scheldt. In the month of September, they built two forts opposite to each other, to command the navigation. As soon as these were erected and armed, they undertook the construction of a bridge; a project, in appearance, chimerical, but, on the success of which, depended that of the Siege of Antwerp. To facilitate the transportation of materials, the Spanish general had a canal dug, whose length was more than two leagues.

"The place chosen for the bridge was at the narrowest part of the river, (between the villages of Ordam and Calloo,) and just below a marked bend, so that the enemy's ships could not fall perpendicularly against it. In order to establish it, long ranges of strong piles were first driven in on each side of the river, until the depth of the water prevented any further progress. They were fastened together by strong and solid timbers, placed traversely along the whole length of the range. These were called *stockades*. One of them was 200 feet long, the other 900; and they left between them a space of 1,300 feet. Upon each of them a place of arms, capable of containing a body of troops sufficiently numerous to defend them, and protect the vessels that were to continue the bridge, was erected. They were covered by a parapet, from be-

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hind which the soldiers might fire upon the enemy without running any risk from him. The two forts, constructed at the two ends of the bridge, or the extremity of the stockades on the land side, protected the flanks of these places of arms. For this purpose, they were furnished with a numerous artillery ; batteries also were established in the places of arms. In addition to these precautions, the two sides of the stockade were bristled with strong stakes, sharpened and pointed with iron. These projected to a great distance, and strong piles, driven into the bed of the river, supported them at the level of the water. This arrangement was intended to keep off the enemy's ships, and weaken their attack. When the stockades were completed, the vessels intended to close the rest, and greatest part of the Scheldt, where it was deepest, were brought up. Thirty-two of these were chosen, 60 feet in length, and 12 wide ; they were placed at the distance of 22 feet from each other, and each fixed to its place by two good anchors. They were then fastened together by strong chains. Each of them was manned with thirty soldiers and four sailors, and armed with a piece of cannon at each end. The whole number of cannon distributed along the stockade and the bridge was 97. The bridge was, moreover, covered by an exterior work, to put it beyond the reach of any attempt. It was known that the besieged was constructing fireships, with which he meant to attempt to burn the bridge ; and it was, besides, found that the vessels they had armed in the city might come down and attack it, at the same time that the ships of the confederates did the same from below. In order to guard it from this double danger, large rafts were made of a great number of stout masts, solidly fixed together, and placed in the water along the whole extent of the bridge. These presented to the enemy a sort of rampart, or large parapet.

" This great work was 2,500 feet long, and cost some months of constant fatigue and labour. It was finished in spite of the most strenuous efforts of the besieged, who fought the most bloody actions in order to interrupt it. It was not completed until the 25th of February, 1585.

" The besieged, on their side, left nothing untried in order to destroy this wonderful undertaking. Besides the vessels they had armed to impede or delay the work, they resolved to employ several vessels of a new construction, filled with fire-works, to destroy

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it when finished. An Italian engineer, named *Giambelli*, invented and constructed these vessels, that have ever since been known by the name of *Infernal Machines*.* They were built of stout timber, and well fastened, and had in their centre the chamber of a mine, of a size proportioned to their tonnage. This mine was built of brick with good mortar of lime and sand. These terrible vessels were loaded with blocks of stone balls, and numerous other heavy articles, that were heaped together as closely as possible, in order that the effect of the mine might be increased by the strength of the resistance. Giambelli employed eight whole months in getting every thing in order.

"During the same time the besieged laboured upon the construction of a vessel of enormous size, intended to attack the redoubts the besieger had raised on the bank of the river, to prevent the passage of the armed ships of Antwerp. This was a ship of two very lofty decks, the lower of which was armed with cannon; the upper was a large place of arms where a large body of troops were posted to keep up a fire of musketry from their lofty station. This enormous vessel had only two masts of equal size, one of which was placed at each end. The two ends were nearly alike. In order that it might approach as near as possible to the redoubts erected by the besiegers on the bank of the river, it was made completely flat; and did not sink into the water as deep as its enormous bulk would have rendered probable, because it was floated on a great raft of timber, and supported by empty barrels. The besieged named this ship "The War's-end."

On the 4th of April, two of these great fire-ships made their appearance on the river, one called the Fortune, the other the Hope, followed by several smaller vessels. They were all committed to the current, and having no one on board, they floated, abandoned to themselves, on the ebb tide. One of the smaller vessels blew up when still a long way from the bridge, and produced no other effect than that of throwing up a thick smoke. All those of the same construction were productive of no better effect than to throw up a thick cloud of dust. The besiegers had now nothing to fear but from the two great ships that approached them slowly. The

* The English, and we after them, call them *Fire-Ships*.—Tr.

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first of these, (the Fortune,) grounded on the left side of the river, burst with a terrible noise, and reduced to dust the garrison of a redoubt in the vicinity, together with several soldiers dispersed in the neighbourhood. However dreadful was the effect of this vessel, that produced by the Hope was still more so, and caused a greater alarm. This vessel had floated towards, and exploded near one of the stockades. The air remained for a long time obscure; the shock the earth received was felt several miles; the Scheldt was driven from its bed, and its waves were forced in foaming impetuosity over its banks. A thick shower of stones, and all sorts of deadly instruments, hurled from this volcano, fell on every side, and wounded, killed, or maimed great numbers. Five hundred of the besiegers perished, and thousands of others were lamed or dreadfully hurt. The damage received by the bridge was not so great as had been feared, but such was the disorder, that had the besieged sallied out at this moment, they might have gained all they desired. But they had no intelligence of the dreadful action of their infernal machine, and the besieger set so good a face on the matter as to lead them to believe that the bridge had not suffered.

"The citizens of Antwerp had no longer any hope but in the great vessel that they called the Wars-end. She was at last tried, and this great castle approached one of the redoubts on the Brabant side of the river. Those on board of it commenced a terrible fire, more than a thousand of them were busied in aiding by musketry the action of her cannon; some of them even land to attack the redoubt more closely; but without success. The fort braved their batteries, and the assaults on the garrison were useless. On the other side, their enormous ship was so cut up by the artillery of the redoubt, that it was with great difficulty repaired and put into order to act again. The second attempt was as unlucky as the first, and all the efforts that they afterwards made, both to carry the works and to destroy the bridge, were equally unhappy. At last famine compelled the besieged to surrender, on the 17th of August, after near a year's siege.

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SIEGE OF OSTEND, BY THE SPANIARDS.

Henry Haestens has published, in 1601, a relation of the siege of Ostend, under the title of *The new Troy, or memorable history of the Siege of Ostend.* This siege is, in fact, one of the most remarkble on record; is that in which the most bravery and genius was employed on each side, and it is also one of the most certain proofs that a garrison that may be refreshed and revictualled at pleasure is unconquerable. There were at the siege of Ostend a great number of assaults made with bravery, and repulsed with obstinacy; and, at the last, the besieged did not surrender until there was no earth left for new retrenchments; nor even then without a formal vote of the States General, to whom the length of this siege had afforded the means of indemnity, by enabling them to wrest from the Spaniards several other cities not less important to them than Ostend. The besiegers remained before the place three years and seventy-eight days, and lost in the siege more than 70,000 men. The noise of the artillery was so great, that it is said to have been heard as far as London.

OTHER SIEGES.

General Carnot cites, in addition, the fine defence that M. de Chamilly made at GRAVE in 1674, where he attacked the besiegers in their very camp.

The Siege of Belgrade, in 1455, where John Corvin, the governor, better known under the name of *Huniad*, sustained the most terrible assaults of the Turks, commanded by Mahomet II. in person, drove them from the town after they had entered it by a breach, and at last compelled them to raise the siege with loss.

"*The Siege of Candy*, in 1667, where the celebrated Venetian general, Morosini, sustained fifty assaults, fought more than forty subterranean battles, and turned off the action of the besiegers' mines more than five hundred times.

"*The famous Siege of Metz*, in 1552, by Charles V. when the Duke of Guise, with no more than six thousand French, held out for 65 days against the most obstinate efforts of the most powerful sovereign in Europe, with an army of 100,000 infantry, 1,200 cavalry, and a numerous artillery; and compelled him at last to retire, without venturing to make an assault, although he had made several practicable breaches.

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OF THE GARRISONS, MAGAZINES, AND STORES OF FORTRESSES.

GARRISONS.

There can be no general method of determining the strength of the garrison required to defend a fortress. Two places of equal circuit may differ extremely in the respective number of troops they require. One, for instance, may be accessible upon all its fronts, while another can be attacked upon one only. It is very evident, that the last will not require as many defenders as the first, where measures of precaution must be taken in every direction. The part a place is likely to play in the war, has also a great influence on the strength of its garrison. If it be only intended to defend the passage of a defile, it requires no more than exactly men enough to enable it to fulfil this object; but if it is to serve as a place of arms to support operations against the flanks or rear of the enemy's communications, it ought not only to be provided with troops for its own defence, but enough to act in the field against the enemy's army; or, lastly, if it is to defend the entrance of a harbour, or the mouth of a great river, it ought to be provided with troops to guard it against a land attack, and also with those required for the service of the seacoast batteries, that often demand a numerous force, in consequence of their number and importance. It may hence be seen, that the strength of the garrison of a place must be calculated from its extent, the number of works, the ease of access to its several fronts, the service de-

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manded of the engineer and artillery departments, and the part it will probably perform on the theatre of war.

The following calculation will serve as a basis on which to form an estimate of the garrison of any particular place.

OF THE GARRISON REQUIRED TO DEFEND A HEXAGONAL FORTRESS, WITHOUT EXTERIOR WORKS, AND ATTACKABLE ONLY UPON ONE OF ITS POINTS.

The force of this garrison must be determined by the number of men necessary for the different services at those epochs of the siege when most are wanted.

There are three distinct species of service. 1. That of the Artillery; 2. That of the Musketry; 3. That of the Labour of the defence.

The service is arranged in thirds, that is to say, when one third of the garrison is under arms, another remains in bivouac ready to march, and the rest sleep. (When the garrison is very strong, half of it may take their rest, and the two other services be performed by the remaining half.) The troops are relieved every twelve hours, in order that the men may not be too much fatigued, and that the service may in consequence be better performed. Indeed only half of the second third may be bivouacked; one half of the guard that is relieved bivouacking for the first six hours, and the other half for the remainder of the time. In this way each soldier having 18 hours of entire repose in every 36, will be fatigued as little as possible, and the garrison more able to fight vigorously.

Service of the Artillery.

There are required for the service of a 24 or 18 pounder mounted on a battering carriage,	2	matrosses and	6	assistants.
For a 12 pounder or long 6 pounder	2	do.	4	do.
For a howitzer, - - -	1	do.	4	do.
For a 12 inch mortar, - -	1	do.	4	do.
For an 8 inch mortar, - -	1	do.	2	do.
For a stone mortar, - -	1	do.	4	do.

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On this supposition, the 72 pieces of heavy and medium calibers which are required for the armament of a hexagon, (without counting field pieces,) will require 120 matrosses, and 320 assistants, for each relief. In making this estimate, it is supposed that 24 of the pieces are 24 or 18 pounders, 24 12 pounders, 24 howitzers, mortars, and stone mortars. But each piece does not fire more than from 10 to 30 rounds in 24 hours, during the two first periods of the siege, nor more than 50 during the last period; and it is known that the same men may fire 120 rounds in 24 hours, without being fatigued; hence it follows, that each squad may serve two pieces, near to each other, and even 3 or 4 during the first period. Sixty matrosses then, and 120 assistants, will serve the 72 pieces, and if we add 12 matrosses, and 50 assistants, employed in the manufacture of fire-works, cartridges, &c. there will be required 72 matrosses, and 210 assistants, for a relief of this service; and for the three reliefs, 216 gunners, and 630 assistants. (The latter are furnished by the infantry.*)

It may be laid down as a general rule, that 3 matrosses should be allowed to each piece, and 3 assistants to each gunner when the pieces are on battering carriages.

It is proper to mention, that if the guns were mounted on garrison carriages, the heavy pieces would require only 5 men instead of the 8 necessary when they are upon battering carriages.†

As for the field pieces that are used in the covered way, and for sorties during the first periods of the siege, they may easily be served by the same men as the other pieces, for all the guns are not fired at the same time, and gunners may be called from the bivouac for the purpose.

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* The extraordinary labourers in the workshops of the artillery are drawn from that part of the garrison which is in bivouac.

† A heavy gun may be served with only four men, when there is a piece near at hand, from which the assistants may be drawn to run it to battery; or even with three men, if a cushion, with a weight of 12 pounds suspended on each side of it, be employed to stop the vent; this weight is equal to the pressure a man gives in performing that action. One of these three men goes for the charge, the two others (one of whom is an artillerist) spunge and load, the gunner then comes and takes aim. In the same way a large mortar may be served when the men at a neighbouring mortar assist in raising the bomb.

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In case of need, the service of such a place may be performed by 180 gunners, by sending to the bivouac only half the number employed in active service; say two fifths upon guard, one fifth in bivouac, and two fifths at rest.

By allowing only 8 men for the service of two pieces, and even only 3 or 4 when they are near each other, and when they can fire the prescribed number of rounds with four men, a less number of men are exposed to the fire. When the fire against any particular point is to be increased, or a few rounds to be fired rapidly, men are brought from among those who are kept in reserve; or else from the bivouac, this being one of the extraordinary services.

Why, it will no doubt be asked, do you put more pieces in battery than can, or ought to, be served with vivacity? The reason of this is, that the fire is not a slow one regularly executed, but that it is sometimes doubled, tripled, nay, quadrupled, on some particular point; in cases when the enemy is fairly within reach, when his batteries or lodgments are to be overwhelmed. Besides, if there were only a small number of pieces in battery, the fire would always proceed from certain points, on which the besieger would direct his fire and render them untenable.

We shall now inquire into the number of artillerymen that will be needed at the several epochs of a siege, if the service be regulated as above directed.

During the investment, there must be 2 matrosses and 6 assistants in each bastion barbet, that has three 24 or 18 pounders in it; 2 matrosses and 6 assistants in each bastion and half-moon barbet that is mounted with 12 pounders; 1 matross and 4 assistants to each separate heavy mortar; 1 matross and 2 assistants to each small mortar. These will, together, make 36 matrosses and 100 assistants, to which must be added 12 matrosses and 36 assistants more, who remain with the pieces kept in reserve to be transported, with ammunition, to the front of attack as soon as the trenches are opened. (In this they will be aided by 150 assistants from the bivouacs.) At the opening of the trenches, there will be then 48 matrosses and 136 assistants employed with the pieces; so that of the 72 matrosses of the division, there will be 24 left to employ in the labours that must be performed by the artillery; to these may be added 80 assistants. When the trenches are opened, each relief of assistants of the artillery must be increased to 360 men to

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hasten the work; but at the opening of the second parallel, towards the fifth night, these men must be restored to the infantry to keep up a fire of musketry, that now begins to act upon the besieger with effect; at this period, if the labour has been conducted with activity, if the batteries have been, as far as possible, foreseen and prepared, or every thing disposed beforehand to establish them quickly, the labour of the artillery service will be nearly over. After this the service of the cannon and the daily work may be performed by 60 matrosses and 216 servants; thus restoring to the service of the infantry 144 men. At the epoch of the third parallel, the 60 gunners will be required for the service of the pieces alone, for they must then be served with spirit; but even if 36 matrosses be allowed for killed, wounded, or sick, the service will still be well performed.

Those infantry soldiers who are to be attached to the guns during the siege, must be taught the exercise of them before hand, and remain constantly attached to that service.

Of the Service of the Labours of the Defence.

There must be at least 500 labourers and 80 carpenters, to construct arrows, double palisades, tambours, bridges of communication, reducts, or retrenchments in the places of arms of the bastions and half-moons. The carpenters may be procured from among the inhabitants, and the whole actively employed until the opening of the second parallel. At this time, at least 200 men must be returned to the infantry, but the remaining 300 must be kept at least two days more to complete the several works. After this, not more than 100 men will be daily needed for the necessary repairs; and they may be furnished by the guards of the fronts that are not attacked, or from the bivouacs, which are established to act in cases of extraordinary pressure.

Infantry Service.

Several authors do not allow more than 3,000 infantry for the defence of the hexagon, of which we are now speaking. But this estimate appears to be too low. Others make it at least 4,200

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men.* I believe that it is impossible to act with less than 3,950 infantry, as we shall see by examining how many men are necessary for each relief in the three services.

For the musketry of the front of attack and of the adjacent half fronts, with the interior posts, - - - - - - - -	900	men.
For each front not attacked, including the interior posts, less than 50 cannot be allowed, so for three fronts and the two half fronts, there will remain, - - -	200	
For the artillery assistants, without reckoning the matrosses, - - - - - -	216	
Total for one relief, - - -	1316	
for the three do. established for the service, - -	3948	foot soldiers.

The following is their employment: from the investment to the opening of the trenches, about 480 men in the outworks of the place, as has been said under the head of Investment; 300 men in the covered way, of which no more than 180 remain during the night; 120 on the ramparts of the place; 80 men within to maintain order; there will then be left 100 men to begin the labours of defence, in addition to 216 left with the artillery; 60 horsemen must be allowed in addition during the day, and 30 during the night.

From the opening of the trenches, until the commencement of the second parallel, about 150 men are detached to the artillery, and 400 to the labours of the defence, as has been before stated; during this time, there are only 250 men employed on the front of attack, which, at this moment, is sufficient, for the enemy is beyond the range of the musket; but from the time the second parallel is opened, 350 men are returned from the artillery, and

* Vauban allows for each bastion of a hexagon, 670 men, of whom 60 are artillery, 60 cavalry, and 10 sappers; and one eighth more for the guard of the gates, the lost, and the sick. These together, make 4,500 men for the hexagon.

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the works of defence, to be used in firing musketry ; and in two or three days the works return 300 more, so that the infantry of the front of attack is increased to 900 men. If half the second relief be added, there will still be no more than 1,350 men to keep up the fire of musketry and make sorties at the most important time of the siege ; that is a little before the establishment of the third parallel. And this number is obtained on the supposition that the garrison has not suffered any loss, which cannot be true. Making a deduction for this, the number may be stated at 1,200 men.*

Forces of the Garrison.

From these data we may estimate the force of the garrison as follows, viz.

Infantry, - - - - - - - -	3950
Matrosses of the artillery, - - - -	216
Mechanics and workmen of do. - - -	20
Soldiers of the engineer corps, - - -	80
Cavalry, - - - - - - - -	150
Total rank and file, - - - -	4416
Add, for officers and non-commissioned officers of all the arms, - - - - - -	350
Staff, - - - - - - - -	24
Store keepers, attendants on the sick, servants,	210
Total number of persons drawing rations,	5000
Horses of the cavalry, - - - -	150
of the artillery and staff, - - -	50
Total number of horses, - - - -	200

* The extent of the covered way of a front of attack, is from 460 to 600 yards, according to the size of the polygon of construction. The front of attack, and the collateral places of arms, will then require not less than 7 or 800 men to keep up an adequate fire, and 200 for the bastions and half-moons.

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(At least 30 horses are needed for the movements of the artillery when the batteries are arming, and for the carriage of ammunition to such places as are accessible for horses.)

It is to be observed, that when a place of any magnitude whatever can be attacked only on one of its fronts, a garrison of 4,400 soldiers, as above detailed, will suffice for its defence; merely adding for the guard of the fronts not attacked, as many times 150 infantry as there are fronts to the place, more than 6; unless when the labours of the defence are greater than usual, the circumstances in the fortification peculiar, or a population to be kept in awe; any of these would require a small addition to be made to the garrison.

For example, in a place with 20 fronts, on which two single attacks may be made, or one attack comprising two fronts, as usually happens in great places; there must be first 8,800 men to meet the two attacks, and guard twelve of the fronts; and 1,200 more for the guard of the other eight; in all, 10,000 men. (Six hundred men more are added for every horn-work, and 150 for each detached redoubt.)

There is no place in Europe, (says Bousmard,) which cannot be defended in the most vigorous manner, against two single attacks, by 12 or 13,000 men; against three attacks, with 15 or 16,000 men; and against two single attacks, and one double, (which is thought to be as much as can possibly be made,) with 19 or 20,000 men.

In polygons less than the hexagon, the garrison may be diminished about 400 men; because the collateral fronts have less action upon the attack, and there is a less circuit to arm and defend.

Of the Inhabitants.

From among the citizens are taken, in the first place, all the workmen who can be of any use; the carpenters, smiths, wheelwrights, and armourers; these are attached to the artillery and engineers, to execute their several works; persons are also detailed to assist in the bake-houses and hospitals;

All those who are able to carry arms are next organized into companies, and employed in the least exposed situations, and those least important to the safety of the place;

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The rest are divided into as many brigades as there are separate quarters, to extinguish fires, and clear the streets of the rubbish produced by the enemy's artillery. Some must be employed at the engines; others provided with fire-buckets, axes, ladders; others again with pincers to draw red hot balls from the wood in which they may have lodged, and plunge them into pails kept filled with water, in the different stories of the houses, and in front of their doors. Fire watches must be placed in posts of observation, and others continually patroling. These brigades are commanded by the most influential, and best affected, of the inhabitants.

This useful employment keeps the population attentive to its own immediate interests, confines each person to his own quarter, and prevents mobs and idleness, which are always dangerous.

In addition to these chief measures, the streets most exposed to shells are unpaved, and dung strewed to deaden the splinters.

When all these precautions are taken, bombardments are much less to be feared than is generally imagined.

ON THE DUTIES OF THE GOVERNOR.

The governor should begin to study the place most particularly, both within and without, from the very moment of his arrival; he will thus know where it may be attacked, and what defence it is capable of making; he must examine if more than one attack can be made, if the means of defence can be augmented by the play of water, or any other method; he must estimate the time the siege may last, and calculate, in consequence, the quantity and number of cannon, artillery-men, engineers, infantry, ammunition, provisions, medicines, and other stores, he will require; taking care to increase the last of these, to provide against blockades, and the cutting off of his communication with the country, and in such a way as to last in case the garrison should make a long defence. He ought to examine the neighbouring country to the distance of two days march at least, with the view of ascertaining how much of its productions may be drawn from it, whether the enemy may be delayed and cut up in it, if his convoys may be intercepted; he must also know all the communications to the neighbouring fortresses, from that which he commands. If he has reason to fear that his powder will fall short, he must collect all the salt-petre in the town,

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cause it to be manufactured from the nitrous earth of cellars, stables, &c.; from this he will have powder made.

He ought to require the inhabitants to furnish themselves with provisions for an equal time with the garrison, and even for a longer time, for it is not easy to reduce them to short allowance; the municipal government should provide provisions for the poor who have not the means of supplying themselves; the inhabitants who are not provided for, should be compelled to quit the town; he must require all the provisions to be sheltered from the enemy's fire, in vaults covered with earth, or in blinded shelters made in the court yards and gardens of the houses; he must, particularly, assure himself that these measures are executed. He must examine the size, wholesomeness, and strength of the buildings destined to the several services, and if they are not sufficient, he must substitute blindages for them. He must himself examine the quality and quantity of provisions of all sorts.

"But it is not enough, says *Bousmard*, to have a sufficient garrison, to be armed at all points, to have a full supply of ammunition and provisions, as well as equipments of all sorts for the time the siege will probably last; care must, in addition, be taken to act with the first relief, and dispose of the others, in a safe and judicious manner. For there is no loss so easily brought about as that of men, by overcharging them with service, fatigue, and danger. The artillery too may be quickly destroyed, if it be served with rashness, and exposed at improper seasons; and the ammunition prematurely consumed by making an immoderate use of it, according to the caprice of the subordinate agents of the defence."

The governor ought to establish a strict police, and watch suspicious persons closely; he should have posts in the city, and patroles both on foot and horseback, to secure it from tumult, and prevent correspondence with the enemy. It often happens, that the besieger endeavours to procure the surrender of the place by threats, or by throwing shells to terrify the inhabitants into submission. Such threats are not unfrequently caused by a consciousness of inability to carry on the siege; besides, ought a town to be delivered up on empty menaces; and as for shells, they do not make breaches in the walls, so that their effect ought not to hasten the capture of the place. The governor ought to punish

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severely all seditions, or even disheartening speeches, in order to prevent such means from producing any effect.

Some people maintain, that it is sheer barbarity to sustain a siege obstinately, and beyond the bounds of a reasonable defence; and say, that reproach may be avoided, and even the merit of having made an honourable defence obtained, by holding out till the time arrives to which the ordinary calculations limit the minimum of the duration of a siege. But these calculations have only been made as a basis for the supply of a fortress, and not as an excuse for surrendering before the last extremity. "These sentiments," says *Carnot*, "are very pernicious, for when the ear listens to the language of seduction, persuasion does not fail to follow, the bonds of discipline are relaxed, and courage abated; the really intrepid defender sees himself abandoned by his comrades one after another, every thing is enervated and corrupted around him, he all at once finds himself singular in his views, and perhaps considered as a dangerous character. It is necessary for the security of a fortress, to proceed with severity against the first authors of such dangerous discourses, suggested, too often, by the enemy; spread about by his emissaries; and forming the spark of sedition, the effects of which it is at last too late to arrest." We shall close this subject by extracting an account of the qualifications for a governor of a fortress, from the works of the celebrated *Carnot*, whose whole life has been devoted to the glory and prosperity of his country.

"A brave and well informed man, far from permitting himself to be overcome by empty threats, and the bursting of a few shells, is not terrified even when he sees the enemy lodged on the counterscarp, and ready to attack the body of the place. He reflects on the means to be employed on his part to make the besieger fail in his hazardous attempt. He communicates his own confidence to his soldiers, and shows them the advantage their position gives them; a position that commands their enemy's, and that cannot be turned; where they cannot be attacked by forces of a greater front than their own; to which the enemy must approach over a steep road, undermined, and battered in flank and in reverse. He shows his comrades that it is a moment decisive of their glory, and incites them to render themselves illustrious by a defence that will be forever remembered.

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"It is not sufficient that a governor is personally active, he must have the faculty of making himself zealously seconded; he must be possessed of the greatest coolness, of the most assiduous application, must know, foresee, and order every thing. Activity should shine in his eyes, all should be animated by his voice, and be electrified by his aspect; his countenance should inspire confidence, give courage to the weak, and terrify the ill-disposed. *I would rather*, said Chabrias the Athenian, *have an army of Deer commanded by a Lion, than one of Lions commanded by a Deer.*"

OF MAGAZINES AND OTHER SHELTERS.

Many places are not sufficiently provided with bomb proof magazines, nor with subterranean vaults, to preserve provisions and ammunition, shelter the sick, and even the troops who are not on duty. This want must be supplied by blinded shelters, or *blindages*.

A blinded shelter (fig. 85 and 86. pl. 9.) is made of trunks of trees squared on two opposite sides with the axe, placed touching each other, and leaning against a wall so as to make an angle of 50 degrees with the horizon, as fig. 85; or two rows are placed with their tops resting against each other, as fig. 86. When these are a foot in diameter, and placed at such an angle, they will resist the shock of bombs. The supporting wall should be thick and well built. These shelters are often supported by the revetment of those works that are not exposed to any fire.

If the blinded shelters have two slopes, (fig. 86.) they are supported by other logs placed horizontally upon posts.* A building also may be blinded, and a good magazine made of it, when the walls are $2\frac{1}{2}$ feet thick. It is raised within four feet of the first floor, and the beams of this floor strengthened by stancheons; it is covered with trunks of trees, and timbers laid horizontally; on

* Shelters made of squared wood, placed touching, require an enormous quantity of it. Some engineers say, that if the pieces have a breadth equal to no more than half their thickness, and intervals equal to that breadth between them, they will be quite as strong. The pieces, however, must be joined by cross beams.

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these are laid two or three beds of firewood, and over all is placed two feet of dung, or from four to five of earth.

Of Placing the Gunpowder and Fire-works.

The gunpowder is kept in bomb proof magazines constructed in all fortresses for the purpose. Their vault must be covered with two feet of earth to deaden the shock of shells, and a blinded shelter must be formed before the entrance, covered by a bed of fascines and turf. If the powder magazines will not contain it all, the surplus must be stored in dry and bomb proof vaults. If there be no vaults of this sort, a long gallery should be excavated in the body of one of the ramparts, under that part covered by the parapet so as to be perfectly sheltered from shells. This gallery is made 6 feet high and 6 feet wide; 8 miners, working 12 hours a day, will make one 450 feet long, with two shafts, in 9 days; it will require planks for the coffers.

The stores that are kept along with the powder, are fire-works and matches. Fire-works made up, and the materials for making them, require a very dry vault. The laboratory must have a safe and commodious shelter.

Such a one is equally needed for the workshops of the armourers, smiths, and carpenters, and of the mechanics who repair the carriages.

Of Placing of the Provisions.

Corn and Flour, which are very important, and difficult to keep, ought to be put into well aired and dry vaults, in bomb proof buildings, or if neither of these can be spared, in the basement story of a house, blinded as has been described above. The *Dried Vegetables, Salt, Spices, Tobacco, Oats, and Salt Provisions*, (which are all kept in barrels,) must be next placed in safe shelters, whose humidity renders them unfit for the last-mentioned purposes; and the *Spirituous Liquors, Vinegar, Oil*, and other *Liquids*, may be placed in those which are dampest.

The *Forage* for the horses and cattle should, if possible, be in bomb proof shelters too, but for this purpose it must be pressed in bundles to ¼ of its former bulk. When no shelters are to be had for it, it must be divided among a number of small separate

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magazines, because inflamatory projectiles bed themselves in it, and cannot be extinguished.

Fuel, which is very important for the purposes of cooking, and warming the troops, must be preserved from fire with as much care as possible; it may be placed in vaults, if there are any left for the purpose; and if not, in a dry ditch, or in some place at a distance from the attack. It may also be put into cellars, although not bomb proof, covering them with earth enough to keep the shell that breaks through their covering from reaching the wood.

Water. In those places where good water is scarce, there must be large cisterns, vaulted bomb proof, in addition to those that should be in the houses of the inhabitants.

Mills and Bake-house.

If the provision is of grain, and not of flour, the garrison must be provided with hand mills, and they must be placed in bomb-proof vaults. So must the bake-house.

A good hand-mill will grind at least 50 pounds of grain per hour, and as it is probable that the greatest part of the provision is in flour, room will not be wanted for more than 4 or 5 mills.

A baker's oven of the usual size, of 10 feet by 13, will contain 400 rations, and each oven will bake 8 batches in 24 hours. Two ovens then will supply our garrison if kept continually at work, but there must be a relief. Four vaults then will be needed, three of which must each contain one oven, with the kettles, troughs, &c. That vault, whose oven is intended for the relief, will serve as a depot for the flour, and the fourth, entirely free, will answer for storing and distributing the bread. (*Bousmard.*)

Of the Hospital.

By the end of the siege, at least two fifths of the garrison may probably be killed, wounded, or sick; one of which fifths will probably be sent to the hospital to be cured. For the garrison we have allowed above, there must be a blinded shelter for 1,000 sick, in which a square of $6\frac{1}{2}$ feet is allowed for every two patients. As the hospital fills in proportion as the magazine of provisions is emptied, it is proper that they should be placed beside each other.

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Of Placing the Troops who rest.

The troops should, if possible, sleep in safety during the twelve hours that are allowed them for rest in each thirty-six. Blinded shelters are more wholsome than vaults, in which a damp air that seldom circulates engenders diseases among the men, who are necessarily much crowded together.

If no buildings are rased to the first floor and blinded, shelters may be made against solid walls, or the revetments of dry ditches far from the attacks, and on the side of them farthest from the enemy's fire. Each man may be lodged in a space of $6\frac{1}{2}$ feet by two, and as the service is divided into three reliefs, shelters will not be required for more than one third of the garrison. That moiety of the third of the garrison that ought to repose six hours in bivouac, should be provided with blinded shelters in the ditches of the collateral fronts, so that they may be near the covered ways and other exterior works, to the defence of which they may continually expect to be called. (*Bousmard.*)

OF THE STORES REQUIRED IN FORTRESSES.

There are three species of stores required for the supply of fortresses.

1. Stores of Provisions and Hospital Stores.
2. Artillery Stores.
3. Stores of the Engineer Department.

The quantity of these several stores is calculated according to the force of the garrison, and the probable duration of the siege. We have already seen how the force of the garrison is calculated; as to the probable duration of the resistance, it is estimated from the methodical journal of the attack and defence, to which must be added, an allowance for the efforts of courage and industry the garrison may make in proportion to its force.

Fortresses are divided on the same account into three classes.

The time taken up in forming the investment, must be reckoned in laying in the stores; this is 20 days in fortresses of the first class, and from 12 to 8 in those of the second and third; and moreover, if the place may be deprived of its communication with

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those places whence supplies can be drawn, the stores of provisions must be proportionably augmented.

It is to be observed, that the stores of provisions are determined at the breaking out of the war in the following manner :

Upon the Hypothesis of a Defensive War.

Places in the first line, at the full allowance for a siege.

do. do. second line, at half that allowance.

do. do. third line, at one third.

do. on the sea coast, at one third, in ordinary cases, in consequence of the aid which may be drawn in case of emergency from naval and commercial magazines; but fortresses upon islands must be provided with the full allowance.

Upon the Hypothesis of an Offensive War.

The places of the first line are supplied with the full siege allowance.

The places of the second line have, generally, a third of the full allowance, except of those articles that are procured with difficulty; those places in the second line that serve as depots must have two thirds of the full allowance.

The places of the third line have no stores whatever laid in.

BASIS OF THE SUPPLY OF PROVISIONS.

	Daily ration for a man.	Amount of rations for 60 days.
Bread, (the ration is 1½ lbs.)		
If the supply be in grain, of which ¾ths is wheat and ¼th rye, and 15 per cent. be allowed for bran, the ration will require, of grain, . .	1⅙ lbs.	70 lbs.
If the stock be of flour, there must be, of flour, ...	1 1/10 lbs.	66 lbs.
Vegetables.		
Rice, (the ration is an ounce, but it is issued only every other day,) . .	1 oz.	1 lb. 14 oz.

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	Daily ration of one man.	Amount of each ration of a man for 60 days.
Dried vegetables, (every other day,)	2 oz.	3 lbs. 12 oz.
(A head of garlic* to every three men is sometimes issued daily.)		
Salt, ...	½ oz.	2 00
Additional salt, ...		0 04
Meat.		
Fresh Meat, } these are given alternately, say in 10 days, 3 of fresh meat, 3 of salt beef, and 4 of salt pork; unless fresh meat be scarce, in which case it is reserved for the sick, who each receive a ration of one pound.	8 oz.	9 00
Salt Beef, }	4 oz.	4 08
Salt Pork, }	3 oz.	4 08
Salt fish, (which is sometimes given two or three times a week instead of meat,)	10 oz.	
Butter or lard, ...	2 oz.	
Liquors.		
Brandy or spirits, (this is distributed daily,)	$\frac{1}{16}$ of a quart.	$3\frac{3}{4}$ quarts.
Beer, (three days in the week, if given at all,)	½ quart.	
Wine, do. do. do.	¼ quart.	
Vinegar, ...	$\frac{1}{20}$ quart.	3 quarts.
Water, (when a stock is laid in,) .	3 quarts.	180 quarts.
Fuel and Lights.		
Wood, (for cooking and fires,) . .	$\frac{1}{300}$ cord.	$\frac{3}{25}$ cord.
One eighth of the allowance is added for the bivouac,		$\frac{3}{200}$ cord.

* In the American service, onions. Tr.

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	Daily ration of one man.	Amount of each ration of a man for 60 days.
Wood for baking at the rate of 5 cords to 100 sacks of flour, ...		
Charcoal, (in lieu of wood,) . . .	2 lbs.	120 lbs.
Turf, do.	10 pieces.	600 pieces.
Candles, 3 candles, 8 to the pound, are allowed for every 16 men,		11 candles.
When oil is distributed instead of candles, double the weight of it is allowed.		
A quarter of a pound, per day, must be added for each miner.		
Miscellaneous Articles.		
Tobacco, ...	$\frac{2}{4}$ oz.	
Sago, for the sick, estimated at one tenth of the garrison, ...	2 oz.	
Brown soap, (for the sick at least,) .	4 oz.	20 lbs.
Forage.		
Straw for beds, 10 lbs. per month for each person, ...		
Hay for one horse, ...	15 lbs.	9 cwt.
Straw for do.	10 lbs.	6 cwt.
Oats for do.	$\frac{1}{3}$d bushel.	20 bushels.
Forage for cattle, ...	20 lbs.	12 cwt.

When the soldiers have not their camp kettles or canteens, an iron kettle, for each chamber containing 8 men, a wooden platter, an earthen pitcher, and two small kegs to distribute their drink, must be furnished them.

The stores necessary for a fortress may be easily calculated on the above basis, and with reference to the strength of the garrison, and the time the siege will probably continue.

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BASIS FOR THE HOSPITAL STORES.

It may be supposed, that a tenth part at least of the whole garrison will be in the hospital from the very first day of the siege; and that by the end of it there will be one fifth, of which fifth one third is sick of fever, and two thirds wounded. (A fifth more will probably have died.) For these there must be provided physicians, nurses, medicines, and instruments of surgery; furniture for the wards of the hospitals, for the apothecaries shop, and the kitchen. Of the sick, there will be at least one half who must have separate beds.

BASIS FOR PROVIDING ARTILLERY STORES.

The Stores to be provided for the artillery, depend on the nature of the place, and the probable duration of the siege. A place, that may be attacked upon two points, evidently requires more artillery than if it could only be attacked upon one; one, where the front of attack may be defended by other works than the collateral half-moons, must also have more artillery to take advantage of this circumstance; if the besiegers works can advance but slowly, on account of the nature of the fortification, of local difficulties, (rocks, morasses, &c.) or the strength of the garrison, more ammunition must be provided than in other cases: A descriptive journal, therefore, must be made, of both the attack and defence of a place, in order to determine with accuracy the number of guns and quantity of stores necessary for its supply.

For the basis of the armament of a regular hexagon, we have, from estimates of the number of cannon that must be put on a single front and the collateral works, to counter-batter the enemy's batteries and approaches, adopted (see *Attack and Defence*) the following allowance: 48 garrison guns, and 24 other pieces, mortars, howitzers, and stone mortars; besides field pieces. For a place where the front attacked is nearly in a straight line with the two collateral ones, as many guns may be mounted upon each of the latter as on the former, and all will batter the enemy's attacks. In this case, 100 garrison guns are allowed, which is the maximum (not including mortars, &c.) for a place that has not to dread more than one attack.

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If the place is liable to two simultaneous attacks, the artillery is usually augmented one half. In a hexagon, no greater addition can be made, in consequence of the difficulty of lodging the men, the ammunition, and the necessary equipments. But in a large fortress, where this difficulty does not exist, the artillery must be doubled when two attacks are to be resisted, and thus both will be equally opposed. It seldom happens, that a place has more than two attacks to sustain.

Whatever be the number of attacks, 12 light pieces of field artillery of small caliber are usually added, to act with sorties and in the covered way. But in order to be properly provided for this last service, it will be better to have at least 18, if there is more than one attack. In this estimate, the small mortars called cohorns are not included; they are very easily moved, and a number of them ought to be provided, to shower grenades on the enemy during the near attack.

We have seen that places are divided into three classes, according to the numbers of their garrison, and the probable duration of their resistance; a duration which is calculated from the methodical journal of the attack and defence, and the efforts of bravery and industry the force of the garrison will allow.

				Cannon.
The armament of places of the first order has been fixed at				100 to 150
do.	do.	second	do.	70 to 90
do.	do.	third	do.	40 to 60
do.	forts and posts		do.	12 to 30

The time of investment is estimated at 20 days in places of the 1st order

do.	do.	at 12	do. 2d order
do.	do.	at 8	do. 3d order

but as we have already said, this armament is modified according to particular circumstances. If, for instance, the work of the besiegers may be battered from exterior works; if detached works are to be armed; or if parts of the body of the place not included in the attack, are exposed to be taken by main force: the artillery must be augmented. If the place is built upon a rock, or on ground that presents a great number of obstacles, or which confines the attack to a narrow front, less artillery will be needed.

The importance of the place with relation to the operations of

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the war, and the means the enemy can bring to its attack, must also be taken into the calculation of the armament and stores.

Of the proportion of Guns of the different Calibers.

The proportion of the calibers of the guns of a fortress, is as follows, viz: one half of heavy calibers, say one sixth to one fourth of 24 pounders, and one fourth to one third of 18 pounders; the other half of calibers of 12 and 6 pounds, and nearly an equal number of each.

The howitzers, 12 inch and 8 inch mortars, and stone mortars, which together are equal in number to one half the long guns, may be in equal proportions of each, except in places on the seacoast, where all the mortars should be of heavy calibers. On the other hand, there are many places where 8 inch mortars will be sufficient.

The 12 field-pieces may be 6 pounders, and it will be well to have 2 or 3 of them of the caliber of 3 pounders.

OF ARMS THAT SHOULD BE KEPT IN RESERVE.

Rampart guns, 60 of these are allowed for each front of attack, including 20 for replacing those that may be damaged; where none of them are to be had, good rifles are substituted in order to arm the best marksmen.

Infantry muskets. One of these must be kept in store for each soldier.

Carabines. Half the number that there is of horsemen.

Horse pistols. One fourth of do.

Pistols for the miners, two for each.

Carabines for the miners, two for each.

Spare Infantry Sabres, $\frac{1}{10}$ of the number of infantry.

Spare Cavalry Sabres, $\frac{1}{2}$ the number of cavalry.*

* Some military authors fix the number of infantry sabres at 1-50th of the number of infantry, and those of the cavalry at 1-5th of their number. These are too few; others require 1-4th of the first, and as many of the second as there are horsemen; we have taken the mean.

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Scythes, 90, (30 for each breach.)
Pikes or *Forks*, 180.

AMMUNITION, CARRIAGES, AND ACCESSORIES.

Supposing the siege to last 20 days, and the investment 8, the supply of ammunition has been fixed as follows, viz.

Balls.

700 rounds for each gun, ($\frac{1}{3}$ of the 24 pound balls are hollow.)
200 do do added for the increased resistance which is probable, although not in the calculation. (These 200 additional balls are hardly sufficient; but when the increase of resistance can be estimated, it will be better to augment this kind of store in the proportion of 700 rounds for 20 days siege and 8 of investment;* or 20 rounds only may be allowed for every additional day the place will hold out.)†
600 rounds for each field-piece, one fourth of which are case shot cartridges; this quantity is calculated from the use that is made of these cannon in sorties, the counter approaches, and in the service against the heads of the sap.

Shells and Howitzers.

500 *Shells* for each mortar, which is at the rate of about 30 per 24 hours, for they cannot fire with effect until the second day after the opening of the trenches.

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* The expenditure during the investment is trifling; no other guns fire than those on the barbets, and for these 10 rounds a day will be sufficient

† It may be observed, that if the place holds out 25 days more, the pieces will have 1,200 rounds to fire, although many of them (those of brass) will not stand firing more than 1,000 times, according to the common calculation. But it is to be remarked on the other hand, that not more than half the rounds are fired with a full charge, and the rest with charges much reduced, so that the pieces will easily last for 1,200 rounds. This is an additional reason for using ricochet fires with small charges in the defence of places, in order that the besieged may not be left without cannon before his other means of defence are exhausted; the precaution of keeping a few pieces in reserve is not sufficient.

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600 *Shells* for each 8 inch mortar, although they do not fire until the second parallel is established, or not more according to our hypothesis than 16 days, but their service is much more easy and rapid than that of the large ones.

500 *Howitzes* to each howitzer; it is calculated that they do not fire more than one round an hour.

Stones for Stone Mortars, Fire Balls.

1100 or 1200 rounds for each stone mortar; say 80 tumbril loads; each round takes $1\frac{1}{2}$ cubic feet, and a tumbril will carry 15 such rounds. This supply is estimated by knowing that a stone mortar should fire 50 times in 24 hours, (say 20 times during the night, and 30 times during the day,) and is sufficient for 13 days. They do not begin to fire until the besieger reaches his third parallel. There must be as many baskets or beds of plank provided, as there are rounds to be fired.

300 *Fire Balls* are as many as are allowed by some military writers; they reckon no more a night than 5 to each approach on the capitals. I think that this is too small an allowance; three ought to be thrown every night upon each approach, by the large mortars, and 10 by the small ones, beginning at the time of the establishment of the third parallel. This is still much less than is required by other military men, who ask for an allowance of 1,600 for a siege of 20 days.

GRENADES AND BALL CARTRIDGES.

2,000 *Rampart Grenades*; two men placed at each of the three breaches, will each roll 10 of these per hour, during the three last days of the siege.

20,000 *Hand Grenades* is the allowance fixed by a committee of officers; but it is too small. Two men placed at each of the salients that are crowned, and then withdrawn to the traverses, will throw 20 per hour, upon the approaches by sap, for the space of 5 days which is 24,000; four men placed on each of the three breaches, will throw 20 per hour, for 3 days, which is 17,000 more; adding 9,000 to throw from small mortars, and there will be required a supply of at least 50,000.

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75 *Ball Cartridges* for each 12 or 6 pounder to fire upon the attack of the covered way, and in other cases where the enemy is exposed.

15 do for each howitzer.

30 do for each 24 and 18 pounder.

Infantry Cartridges. On the hypothesis of 20 days of trench and 8 of investment, 30 pounds of lead, and 15 of powder, are allowed for each foot soldier in the garrison; or in more general terms, 20 rounds a day for each private of the infantry. It is calculated that each soldier who fires may discharge 50 rounds during his twelve hours tour of duty; but not one half of the guard has an opportunity of doing this; and it is not necessary to reckon upon a regular consumption, until a continued rolling fire is opened from the covered way, which does not happen before the opening of the second parallel; up to that period, the utmost expenditure is not more than 6000 pounds of powder. In the above estimate, the allowance for sorties, and other actions of vigour, is comprised.

Gun Flints. 3 Flints for every 2 pounds of powder, (or one at least for every 20 cartridges.)

Pistol Flints. 20 for every horse pistol in service.

Slow Match. 1½ pounds for the daily service of each piece. (A pound of good match ought to last 60 hours, but it may be of middling quality, and, therefore, 1 pound a day is allowed per cannon, and ½ a pound in addition for fireworks, waste, and improper use of it.)

Lead. 1 pound of lead for every 20 infantry cartridges, (or $\frac{1}{10}$ more if the balls are 18 to the pound,) twice as much for the rampart guns, and 3 pounds for waste in melting, if the lead is in pigs.

Fuses of hollow balls, shells, howitzes, and grenades, ¼ more than the number of these projectiles.

Gun Powder.

The quantity of this is computed in the following manner:

For each Gun, ½ of the weight of ball; (½ is allowed, but it is to be observed, that not more than ¼ of the weight of the balls fired, will be actually consumed, for there must be many rounds of

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ricochet fired with small charges.) $\frac{1}{3}$ must be allowed for the case shot cartridges.

For large Mortars. 10 pounds to each shell. If they are sea-coast mortars, the quantity must be regulated by their largest charge.

For 8 inch Mortars and Howitzers. 3 pounds for each shell or howitz.

For Stone Mortars. $1\frac{1}{2}$ pounds for each round.

For Fire Balls. 4 pounds for those of 12 inches and 2 for those of 8 inches.

For each Rampart Grenade, $3\frac{1}{2}$ pounds.

For each Hand Grenade, $\frac{1}{2}$ pound.

For Infantry Cartridges, 1 pound for 40 cartridges, twice as much for rampart guns.

Mines. For such mines as are constructed at the moment the place is threatened, we have allowed 33,000 pounds of powder. (See *Mines and Defence of Places.*) This quantity may be reduced one half, if only 20 mines are made under the batteries of the crown of the covered way, and the lodgment itself; and 12 under the foot of the breaches.

Fire Works and Waste. $\frac{1}{25}$ of the whole supply of gunpowder.

It appears then that 360,000 pounds of powder will suffice for the defence of a hexagon for a month, ten days of which are employed in the investment, (on the hypothesis of 84 pieces of artillery.)

It will be proper that there should be at least 10,000 pounds of powder left when a capitulation is proposed, in order that an additional defence may be made, if the besieger requires the garrison to surrender at discretion.

Carriages for Cannon and their Armament, Platforms, &c.

Gun Carriages, One third more than the number of pieces, (or twice as many if there are no means of repairing them.)

Howitzer Carriages, One half more than the number of howitzers.

Mortar beds, One half more than the number of heavy mortars, and $\frac{1}{4}$ more than the number of light mortars and of stone mortars.

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Platform Frames for Garrison Carriages, as many as there are carriages of that kind.

Platforms, as many as there are carriages.

Embrasure Shutters, one third more than the number of embrasures.

Carriages and other machines for transportation.

Battering Limbers, one fifth of the number of garrison carriages.

Frames for moving garrison Carriages, as many as limbers.

Gun Waggons, one to every 10 pieces.

Caissons, one to every field-piece.

Carts, to carry ammunition, 1 to every 4 pieces.

Camions, one to every six mortars, stone mortars, and howitzers.

Hand carts, eight to each front of attack, (8 batteries are supposed to be in action at a time.)

Sledges, four.

Sling-carts, (*Triqueballes*,) one to 16 pieces, (for the convenience of carriage, it would be best to increase the number of these, and lessen that of gun waggons.)

Travelling Forges, with full equipments, 2 for the artillery, and 1 for the armourers.

Common Wheelbarrows, one for every battery of guns, and one for each stone mortar.

Wheelbarrow for Shells, one for each mortar and howitzer.

Common hand-barrows, one third of the common wheelbarrows.

Hand-barrows with legs, as many more.

Hand-barrows for Shells,* do.

Engines for raising weights and weighing.

Gins, five, one for every separate combination of batteries, (three half-moons and one front,) one in reserve at the arsenal.

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* Litters for the wounded are furnished from the hospitals, one fortieth of the number of the garrison is the allowance of them.

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Screw-Jacks, four, one for each combination of batteries.
Capstans, four.
Lever-Jacks, four.
Handspikes, ten to each piece, in addition to the ordinary equipment.
Large Steelyards, two.

Cordage.

Falls for the Gins, six for the five gins.
Double Prolonges, two to each gin.
Prolonges, one for every two field-pieces.
Gun-Traces, six to every two gun waggons, (for a description of these ropes, see vol. 1.)
Manœuvring Traces, eight to each gin.
Peasants Traces, as many as of both the other kinds.
Small Cordage, 100 pounds for the 72 pieces of artillery.

Fireworks made up.

Pitched Tourteaux, six per night, for every piece, beginning with the opening of the first parallel; (this upon our hypothesis will require 8,640;) for a description, see *Fireworks*.
Signal Rockets, one hundred.
Fire Stone, (*Roche à feu*,) fifty pounds for 20 days of siege.
Torches, one hundred pounds for do.
Fire-barrels, ten to each breach.
Fire-balls, (see the stores for the stone mortars.)

Materials for Fireworks.

Saltpetre, 1600 pounds for 72 pieces of cannon.
Sulphur, one third of the weight of saltpetre.
Pitch, four tenths of the saltpetre.
Turpentine, three tenths of the saltpetre.
Tar, 3 barrels to each cwt. of pitch.
Wax, same weight as of sulphur.
Tallow, one and a half times the weight of sulphur.
Linseed oil, 30 pounds.

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Rosin, ten pounds.
Venice Turpentine, thirty pounds.
Camphor, six pounds.
Vinegar, five quarts.
Brandy or Spirits, three quarts.
Gum Arabic, three ounces.
Cotton Yarn, five pounds.
Reeds or *Quills*, ten thousand.
} for ten thousand priming tubes for the field pieces.

Cartridge paper, one sheet for every time a gun, mortar, howitzer, or stone mortar is fired; six quires and a quarter, and five ounces of thread, for every 1000 infantry cartridges.

Turning Lathe, to make stools for round shot, one.

Tools for making Fireworks, the complete equipment of two caissons. (See *Field Equipage*, vol. 1.)

Moulds for musket bullets, a sufficient number for three squads of five men each. (See *Preparation of Ammunition*.)

Furnaces for heating balls, for places on the seacoast. (See *Air Furnaces*, vol. 1.)

Tools and Saucissons for the Batteries.

Pioneers tools, eight for every piece of garrison artillery, of which two thirds are usually spades and shovels, ¼ mattocks, and the rest pickaxes.

Masons Levels, one third more than the number of guns.

Paviers Rammers, twice the number of levels.

Mallets, as many as rammers.

Saws, one to every two garrison pieces.

Edged tools, one to each matross, one third of which are axes, and two thirds bill hooks.

Tools of Artillery Workmen, two complete sets for a squad, if there is but one squad, 3 if there are 2, &c.

Armourers tools, a set for 8 armourers, and 4 stock makers.

Saucissons, of a foot in diameter, and 19 feet in length.
- ten to each gun if it be on a garrison carriage, and 13 if on a battering carriage.
- ten to each howitzer.
- eight for each mortar or stone mortar.
- and one third in addition for repairs.

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Gabions, 3 feet in height, and 1½ in diameter.
- 130 for each traverse, and 12 traverses must be counted for 48 cannon.
- 1200 for the paradoses of the two flanks of the curtain of the front of attack.
- and one third more for repairs.

Pickets, 10 to each saucisson.
Withes, 10 spare withes to each saucisson.*

Spare Pieces of Wood work.

Flasks, 1 pair to every 2 pieces.
Spare Heurtoirs or Knockers, 1 to every 4 pieces.
Spare Sleepers, 1 to every piece.
Wheels, without tire or irons, 1 pair to every 2 pieces.
Wheels, Ironed, 1 to every 4 carriages.
Spare Naves, 1 pair to every 4 pieces.
Spare Spokes, 10 to each piece.
Spare Fellies, 5 to do.
Spare pointing plates, 1 to every 6 pieces.
Spare axle-tree beds for gun carriages, 1 for every 4 pieces.
Spare do for limbers, 1 for every 10 limbers.
Spare pieces of wood for aprons, embrasure shutters, &c. 1,800 feet.
Truck wheels, a large one and a small one for every 6 pieces in those places where the guns are on sea coast carriages.
Spare Tool-Handles, $\frac{2}{3}$ of the number of each kind of tools.
Wood to make bottoms for hollow bullets, and other balls, if possible.

Iron.

Spare axle-trees, 1 for every 3 field-pieces.
Pointing Screws, 1 for every 6 pieces.
Mortar flasks, 1 for every 6 beds.
Hausses, $\frac{1}{10}$ more than are in use with guns.
Bar Iron, 2,000 pounds, (upon the supposition of 84 cannon, and 20 days siege.)

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* The engineers usually make the paradoses and traverses, but it may be a matter of arrangement between the commander of that department and the artillery.

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Nails, $\frac{1}{6}$ of the weight of bar iron.
Steel, $\frac{1}{3}$ of the weight of nails.
Sheet Iron, 20 sheets.
Tin Plates, in proportion to the case shot to be made up, and stools to be fitted.

Spare Pieces of Small Arms.

For every thousand muskets, the following spare pieces should be provided :*

Stocks, 50.
Wooden Splices, 150.
Locks, 50.
Pieces, of the mounting, 30 of each sort, except springs, of which there must be 150, and pins, of which there must be 50.
Screws, of different sorts for the lock, 800.
Barrels, 5.

Half the above supply is provided for an equal number of carabines, and one fourth for pistols.

Miscellaneous Stores.

Charcoal, 150 pounds a day, for each forge.†
Rampart Lanthorns, 2 to every gun.
Fire Engines, 1 at the arsenal, and 1 to each great magazine.
Fire Buckets, 4 for every 9 feet between the source of the water, and the position of the engine.‡
Machine for bushing the vent of guns, 1, with all its apparatus.
Box of Mathematical Instruments, one.
Graphometer, one, (or a theodolite.)
A Circumfercutor, and two *Drawing Boards* of different sizes.
Office Furniture, (registers, paper, pen, ink, penknives, rules, &c.)

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* The supply for armies in the field is twice this.

† If smiths shops are erected within the fortress, they must be made for 2 fires, each of which is 9 feet long and 5 wide, the bellows require a space 22 feet in length.

‡ Hose of leather are now adapted to well constructed engines, and have superseded the use of buckets. Tr.

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BASIS FOR PROVIDING THE STORES OF THE ENGINEER DEPARTMENT, (*Bousmard*, vol. 3.)

Wood, Gabions, Fascines.

Three thousand six hundred *Palisades* are required to enclose a single front of a fortress, which makes 21,600 for the six fronts of a hexagon.

For three arrows at the foot of the glacis, the tambours of the places of arms, the retrenchments of the bastions and half-moon, the second palisade of the covered way of the front of attack, 6,200 are wanted.

These 27,800 palisades may be made of 1,750 trees, of from 17 to 19 feet in length, and 51 inches in circumference;* for the barriers, the tambours of the body of the place, and the revetment of the counterscarps of the retrenchments, 1,400 trees more are wanted; for blindages, as many pieces of a foot in diameter, and 5 or 6 yards long, as are required for the shelter of the troops and magazines.

For the work of the mines (of which we have spoken under the head of *Defence*,) 500 joists, 5,600 boards of 12 feet in length, and 340 planks.

If the ditches are filled with water, bridges of communication must be established, for which 20 joists for every 6 running feet are required.

If stairs must be constructed to any of the works, 46 joists are needed for an ascent of 20 feet.

Gabions, for fleches and repairing parapets, 1,700.

Fascines, 6 feet long, 10 inches in diameter, to lay upon the gabions, face the fleches and the scarps of the retrenchments, and for repairs, 7,000.

Sand bags, To line the parapets of the front of attack, 9 bags to every 6 feet, (those for the service of the mines not included,) 10,000.

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* Trees of from 40 to 54 inches in circumference, cut to the greatest advantage in making palisades: a trunk of a tree of 40 inches round will make 6 palisades of 6 inches in front.

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Tools for the Labours of the Defence.

During the five or six first days of the siege, there are 720 men taken from the infantry, and employed at a time on the labours of the defence. And half that number more who are in bivouac for the purpose, may be added in case of emergency. (In this number is not included that of the assistants to the matrosses of the artillery.) There must then be tools for about 1,100 workmen, and to be sure of having such a number always in good order, at least double the quantity ought to be provided, say 2,200 intrenching tools. One third of these are pick-axes, $\frac{1}{3}$ spades and shovels, $\frac{1}{6}$ carpenter's axes, the remainder, mattocks and stone chisels, to destroy masonry. There must also be a number of saws and axes, wheelbarrows, &c.

It is to be remarked that the town must be provided with at least one good fire engine to every two fronts; 20 buckets of boiled leather, 3 hooks, and 12 ladders to each front; $\frac{2}{3}$ of these ladders need not be more than 10 feet long; the other third, from 20 to 30 feet.

Mining Tools.

If we suppose that there are 42 labourers in service, and kept constantly at work, there must be 48 of each of the following kinds of tools: common hoes, pick-axes with broad blades, crooked shovels, gallery hoes, common pick-axes, spades; and in addition, 12 augurs, 16 mason's hammers, 8 large and 8 small chisels; with 50 saws, hatchets, and axes, to prepare wood for the coffers.

Lesser Stores.

Strong bagging closely woven, 18½ yards for each chamber.
Sand bags to stuff the chambers, 150 do.
Rope, inch in diameter, 400 yards.
Iron Lanthorns, 1 to every two miners.
Iron tripod candlesticks, 2 to each miner.
Tubs with handles to carry earth in, 3 to each miner.
Large nails, 10 for each running yard of shaft or branch.
Iron spikes to connect the pieces of boxes, 100 to each box.

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EQUIPAGE OF SIEGE ARTILLERY.

To calculate with precision the artillery stores and equipage required to carry on a siege, the force of the place, its situation, the resources the country offers, and those afforded by the fortresses held by the party that means to besiege it, must all be known.

These circumstances should evidently cause a difference in the composition of the siege equipage. In fact, if the fortifications of the place are good, if the attack is to embrace a double front, and if the garrison is strong, more artillery and more ammunition will be required, than in other circumstances.

The pioneers' tools for the construction of batteries, must be of different numbers and proportions, according to the nature of the ground.

If the place is upon a river, means to make bridges are wanted; if there be no wood near it of sufficient size, the materials for platforms must be procured from a distance; if even copse wood be scarce, fascines, gabions, &c. for the revetments, must be provided before hand, or measures taken to obtain them as they are wanted.

If lines of circum and counter-vallation must be made, to secure the besieging army from one attempting to relieve the place, or from the attacks of the garrison, the field artillery must probably be augmented, and more means provided for the construction of batteries. (The pioneers' tools, &c. for the intrenchments, fall within the province of the Corps of Engineers.) If the country around the place has means of supplying iron, lead, timber,

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coal, &c. it is unnecessary to carry so great a quantity of these several objects in the train.

If some well supplied fortresses, near the fortress to be attacked, are in possession of the besiegers, from which ammunition and spare articles may be drawn during the siege, these places will serve as magazines, and a much less quantity may be transported with the army.

As sufficient data can rarely be procured, to ascertain exactly what should be asked for, the commandant of artillery is often compelled to form his equipage upon a calculation of chances, upon the best information he can procure, and upon circumstances; much experience, and great skill, will then be required to combine measures in such a way, as to prevent the want of any thing during the siege.

The Personal and Material* we shall now detail; and which are necessary for a siege requiring 160 pieces of cannon; will serve as a basis on which an equipage suited to particular circumstances may be formed.

PERSONAL OF THE EQUIPAGE.

General Staff.

1 General, commanding the artillery of the siege.
1 Colonel, chief of the staff.
2 Majors, (in addition to those acting with the companies,) commanding the labours of the attack.
4 Captain Lieutenants.
1 Artillery Guard.

Staff of the Park.

1 Colonel, director of the park.
1 Major, sub-director.

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* The words *personnel* and *materiel*, have become so completely naturalized among the military men of this country, that I have not hesitated to employ their nearest English form, in the very sense in which they are used by the French. Tr.

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6 Captain Lieutenants.
1 Major of the train, to command the carriages and drivers procured by requisitions.
3 Officers of the train, his assistants.
1 Artillery Guard, in chief.
4 Assistant do.
1 Master Artificer.*
1 Veterinary surgeon.

Troops.

20 *Companies of Artillery*, (10 men to every piece of artillery.)
2 *do of Workmen.* Their numbers should be in proportion to the quality of the materials, as well as the number of spare pieces that are carried with the army. Two companies are estimated here as a mean.
Artillery Train. The carriages of an equipage of siege artillery, are too numerous for it to be conducted entirely by the artillery train. Means of transport are for the most part procured by requisitions. No more than 300 carriages are supposed by us to be drawn by the train; these will take 12 companies. They must also furnish the means of draught for the park, the workshops, the depots of the trenches; for the supply and the armament of batteries.

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* By the term artificer, both here and wherever else it occurs, is meant a maker of artificial fire-works. Tr.

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MATERIAL OF THE EQUIPAGE.

*Kind.**		Number.	Weight.	Carriages	Horses.
100 pieces, of which $\frac{2}{3}$ are 24 pounders and $\frac{1}{3}$ 18 and long 12's.†	24 pounders,	68			
	18 or 12 do.	32			
60 other pieces $\frac{2}{5}$ of which are howitzers, $\frac{2}{5}$ mortars and $\frac{1}{5}$ stone mortars.	howitzers,	24			
	12 in. mortars	18			
	8 in. do.	6			
	stone do.	12			
	Total	160			
24 pounder carriages with limbers $\frac{1}{5}$th of which are spare carriages.‡		82		82	328
12 pounder do. $\frac{1}{4}$ spare . .		40		40	160
Howitzer do. $\frac{1}{4}$ do. . .		30		30	120
Mortar beds $\frac{1}{3}$ do. . .		27			
Stone mortar do. $\frac{1}{6}$ do. . .		14			
Gun-wagons to carry the 68 24 pounders (10 horses each.) .		68		68	680
do. 12 pounders (6 horses each.)		32		32	192
Spare do. carrying gins, cordage, &c.		10		10	40
Camions to carry mortars, stone mortars, &c. . .		36		36	216
Camions to carry their beds $\frac{1}{3}$ spare. . . .		44		44	176
Sling carts, 1 to each of the first batteries.		8		8	32
Forges§		4		4	24
Caissons of tools		6		6	24
				360	1992

* Many articles being for the most part transported by carriages that do not belong to the artillery, it is useful to know the weight nearly, in order to calculate the proper number of horses and carriages.

† If the pieces are not in a state to fire each the 1,000 rounds, we suppose to be necessary, spare ones must be provided; on this account it will be necessary to calculate the service they will stand.

‡ If no resources are at hand, the number of spare gun carriages must be increased.

§ It is assumed, that at least four permanent forges will be put up as soon as the army arrives before the place.

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NOTE.—See a recapitulation of the carriages of the train at the end of this article.

Ammunition and Accessories.	Number.	Weight.	Carriages	Horses.
24 pound balls, 1,000 to each gun,*	68000	1,632,000	1088	4352
18 and 12 do 1,200 . .	38400	460,800	307	1228
Howitzes, 800 to each howitzer,	19200	249,600	166	664
Shells, 800 to each mortar, .	19200	2,240,000	1493	5972
Lead in musket bullets, (20 to the pound.)		200,000	133	532
Barrels of gunpowder,† . .	5250	1,050,000	750	3000
Flints,‡ (barrel weighing 700 pounds, and containing 25,000 flints,)	12	8400	7	28
Fuses for shells and howitzes, of which are spare, . . .	48000	13500	9	36
Plank bottoms for charging stone mortars, 800 to each, . .	9600	48000	32	128
Baskets for do. containing $1\frac{1}{2}$ cubic feet of stone, ...	9600	28800	20	80
Bags, for cartridges, 500 to each piece,§	48000	1100	1	4
Cartridge paper, ($\frac{1}{6}$ allowed for waste.) . . reams	230	3080	2	8
do for the infantry, ($6\frac{1}{4}$ quires for 1,000 cartridges,) . . . . . quires	1250	17500	12	48
Thread to tie up the cartridges, 32 pounds, for 100,000, . .		1250	1	
Match, in barrels of 300 pounds,‖ .	24	7200	5	20

* Mr. Dupuget is for supplying each piece with 2,000 balls, large mortars with 1,000 shells, and smaller ones and howitzers, with 1,500; but this is too much. It supposes the siege to be long, and the fire constant. But it seldom happens that 1,000 rounds are fired a piece, and this depends on the strength of the garrison, and the circumstances of the war.

† 100,000 pounds of gunpowder are allowed for infantry cartridges; 25,000 for fireworks and loss: the pieces are supplied with 1-3d of the weight of their balls, but 30,000 pounds at least must be added for mines.

‡ Three are allowed to each pound of powder, or 1 to 20 cartridges.

§ Ready made bags are carried along to give the artificers time to establish their workshops; a sheet of paper is allowed for each round of a gun, and half a sheet for each round of a mortar or stone mortar.

‖ One pound per day to each cannon, and one half in addition for Fireworks, waste, &c. It is supposed that the guns are 30 days in battery.

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Equipments and Implements for the Batteries.	Number.	Weight.	Carriages	Horses.
Equipments for guns, as many complete sets as there are gun carriages,*	122	20000	13	52
do for howitzers, do .	30	2600	2	8
do for mortars, do .	27	2700	2	8
do for stone mortars, do .	14	1176	1	4
Platforms for guns,† . . .	100	200,000	133	532
do for howitzers, . .	30	60000	40	160
do for mortars, . .	27	30000	20	80
do for stone mortars, .	14	15000	10	40
Shutters for embrasures, $\frac{1}{2}$ as many as cannon, ...	50			
NOTE.—We suppose that the gabions, saucissons, and pickets, are constructed in the woods, near the place to be besieged.				
Pioneers Tools‡ Spades, shovels, pick-axes, 30 to each piece of artillery, including spare ones, . .	4800	25600	17	68
Axes, (5 to each piece,) . .	800	4400	3	12
Bill Hooks, (10 to each piece,) .	1600	2400	2	8
Spare handles for the tools, $\frac{1}{20}$ or $\frac{1}{10}$ if the country is such that they cannot be procured, .				
Saws of which $\frac{1}{5}$ are long ones, (*pit* and *cross cut*,)§	50			

* For the detail of this article, see the exercise of the several pieces, vol. 1.

† If they are of pine, with only the knocker of oak, the weight will be one fourth less. If wood fit for platforms be handy to the place, very few need be carried with the equipage.

‡ In ordinary ground, one third of each kind of tool is provided. The Corps of Engineers should have a separate park to furnish the army; but if the supply is to be drawn from the artillery, a pioneers tool must be provided for each soldier, or for four-fifths of them: edged tools also must be had to the number of 7,000, to make fascines and gabions for the trenches.

§ At least twenty long saws must be added to cut up wood, when it is expected that it will be met with in the country; in this case, fewer platforms will be carried. The tools of the workmen in wood are carried in caissons; those of the smiths, along with the forges. For the mode of supplying deficiencies in them, see the head of Field Equipage.

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	Number.	Weight.	Carriages	Horses.
Tools to construct platforms.* Rulers,	160	640	11	44
Mason's levels,	160	320		
Rammers,	489	7680		
Mallets,	480	7680		
Miners tools (necessary sometimes in the construction of batteteries.) Pistols,	16			
Needles,	8			
Pincers,	8			
Mallets,	16			
Wedges,	16			
Miscellaneous Articles.				
Wheel barrows, ($\frac{1}{5}$ for carrying shells,)	30	2100	2	8
Hand barrows,	10	380		
Hoops to repair powder barrels,	300	600		
Chevaux de frise, (must not be forgotten.)				
Scaling ladders, if needed,†				
Lanthorns, and sheets of horn to repair them, in equal number,	160	320		
Tarpaulins‡ to cover the powder, 10 yards to each carriage,				
Scythes for mowing,	8		2	8
Grease for the wheels of the carriages,§		850		
Mill stones,	4			
Machine for bushing vents,	1			
Rampart lanthorns,	60	420		
Steelyards,				
Sledges,	5	1100		
Eprouvette with its ball,	1	364		

* If they can be constructed in the neighbourhood of the place, but few are carried along.

† Both of these ought to be provided by the engineers, but if the artillery is obliged to furnish them, four waggon loads of them must be reckoned. The ladders ought not to be longer than 20 or 30 feet; they are, even then, heavy and difficult to place.

‡ Instead of tarpaulins, strong bagging painted with two coats of oil colour may be used.

§ Twelve pounds a day are allowed for 100 carriages, while upon the march, so that if the supply is calculated for 10 days, it will take 850 pounds for the 710 carriages of the artillery. It is an article that is easily renewed.

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	Number.	Weight.	Carriages	Horses.
Charcoal,*		36000	24	96
Sand bags, (those for the trenches are provided by the engineers, nearly 25 waggons may be loaded with them,)				
Engines to raise weights.†				
Gins with their pullies and ropes,‡	10	6480		
Pullies or blocks, . . .	10	900		
Screw Jacks, ...	20	1000		
Lever Jacks, ...	50	1200		
Cordage.				
§ Spare gin tackles, . . .	10	1000		
§ Double prolonges, . . .	75	1500		
§ Single do. . . .	75	750		
§ Pairs of gun traces, twice the number of guns, . . .	300	1650		
‖ Pairs of manœuvering traces, .	200	600		
‖ do. of peasant do. .	400	1000	2	8
‖ Small cordage, . . .		200		
‖ Wire of different sorts, . .		50		
Fire-works.				
Salt petre, ...		2000		
Sulphur, ...		200		
Pitch, ...		200		
Turpentine, ...		200	2	8
Beeswax, ...		300		
Tallow, ...		300		
Charcoal, ...		100		

* Besides the four travelling forges, four permanent ones are erected near the park. One hundred and fifty pounds of charcoal at least must be reckoned as the daily consumption of a forge. The quantity carried along may be diminished if it can be found near the place.

† These articles are carried on spare gun waggons.

‡ To furnish eight batteries, and have two spare ones, one is reckoned for every 25 carriages to be greased.

§ Carried on spare gun waggons with the exception of two thirds of the gun traces.

‖ With these are carried the other two thirds of the gun traces.

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	Number.	Weight.	Carriages	Horses.
Camphor,		50		
Venice turpentine,		50		
Oil, $\frac{1}{5}$th fish oil and $\frac{4}{5}$ths linseed, gals.	3			
Torches or flambeaux,	100			
Tow,		25		
Spun yarn,		50		
Tarred yarn,		300		
Steel wire,		10	1	4
Brass do.		10		
Cotton yarn,		20		
Glue,		5		
Reams of coarse paper,	10	90		
Barrels of tar,	2	400		
do. of meal powder,	1	250		
do. of priming tubes,	1	150		
Tools,			1	4
*Instruments for firing Red-hot Balls.**				
Fire tongs,	8			
Forks to lift the balls,	8			
Grates, one fortieth of the number of pieces of cannon,	4			
Tongs, one twentieth,	8			
Ladles, one twentieth,	8			
Bellows,	10			
Small Articles of Equipment.				
See Field Equipage, vol. 1.			1	4
Spare Wheels, &c.				
Gun wheels, one twentieth,	12	4400		
Howitzer do. one sixteenth,	4	950		
Gun waggon do. one thirty-sixth,	12	2700		
Cannon and cart do. one twenty-fifth,†	16	3840		

* These at present are seldom used in sieges. AUTHOR. If, however, much of the fortification is of wood, they may be employed to great advantage, as was proved by the Americans at Fort George, (Niagara.) This fort, situated on a point at the bend of the Niagara river, was set on fire, and rendered untenable, by a few hours fire of red hot shot from batteries on the opposite bank of the river, placed like those of the first parallel in a siege. TR.

† Three hundred and thirty-five ammunition carts are calculated as necessary to carry the first part of the powder and projectiles.

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	Number.	Weight.	Carriages	Horses.
Limber wheels, one fiftieth,	6	660		
NOTE.—The spare wheels of ammunition waggons, forges, caissons of tools, fire-works, &c. are carried on the axle trees of the service caissons.*				
Spare pieces, as detailed hereafter, Spare pieces of wood put together, and either ironed or not,		15000	10	40
Pieces of iron made up, and bar iron,		22000	15	60
Recapitulation of the weight of the articles and of the carriages.				
The weight to be carried, beginning with the ammunition and its accessories, is about		6,440,000 lbs.		
which will load at least			4350	18000

If we add to the 360 artillery carriages, mentioned above, 350 more, which is a large number, and employ them as follows, viz:

For tools, materials for fire-works, and small articles,		4	caissons.
For edged tools, (axes and bills,)		5	do.
For carrying 10,000 balls,		110	carts.
For do. shells and howitzes,		50	do.
For do. infantry cartridges,		25	do.
For do. 120,000 pounds of powder,		100	do.
For do. fuses, flints, and match,		3	do.
For do. charcoal,		3	do.
For do. ½ of the armament and equipments of the platforms, the spare pieces of wheels, wood and iron,		50	do.

There will still remain, after loading these 710 carriages, a sufficient quantity of ammunition and other articles to load 4,000 more. Such a number can only be procured by requisitions; for no num-

* If the number of ammunition waggons in the equipage, be too great in proportion to the caissons, carriages must be provided to carry their spare wheels.

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ber of companies from an artillery train could be found adequate to transport such a *material* from its several places of deposit to the camp of the besieger. Even a part of the horses, for the first 710 carriages, must almost always be procured by requisitions.

All this, too, is independent of the objects of transportation required by the engineer department, such as sand bags, tools, &c. for the trenches.

Tools for the workmen in wood and iron, must be provided in proportion to their numbers, and to the repairs and constructions that are to be made.

SPARE PIECES OF WOOD AND IRON.

The number of spare pieces must depend upon the state of the carriages of the equipage, upon the length and nature of the roads, and upon the supplies that can be procured from the country through which the besieging army marches. On this account, no exact proportions can be laid down, but as a guide in case of need, we shall give a scheme that may be observed in many instances.

*Wooden Pieces either plain or ironed.**

Poles, perches, swivel trees, braces, hounds, transoms, fore axle tree beds, from $\frac{1}{15}$ to $\frac{1}{30}$ of the number in service.

Hind axle tree beds $\frac{1}{6}$: half that number for the waggons.

Spokes, 1 to every 4 wheels; fellies, 1 to 8 wheels.

Handspikes, twice as many as cannon; priming wires, $\frac{2}{3}$ that number.

Screws or worms $\frac{1}{12}$, spunges $\frac{1}{2}$, rammers $\frac{1}{6}$, copper ladles $\frac{1}{15}$.

Gunners quadrants, $\frac{1}{4}$ of the number of mortars.

Iron Pieces.

Trunnion plates and cap squares $\frac{1}{20}$ to $\frac{1}{40}$.

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* Only two thirds of the spare wooden pieces need be ironed, for the iron of the broken ones can often be made to answer.

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Limber bolts ;· flat headed bolts, bolts with clinches; cap-square keys ; linchpins ; washers ; retreat hooks, $\frac{1}{30}$ to $\frac{1}{50}$.

Tires, $\frac{1}{6}$ for gun carriages, $\frac{1}{15}$ for waggons and limbers.

Felly, spoke, and pole bolts; axle-tree bands, from $\frac{1}{15}$ to $\frac{1}{40}$.

Pointing screws $\frac{1}{15}$, nuts for do. $\frac{1}{30}$. Nuts for bolts of three different kinds, three times the number of cannon ; common nails, one pound to each gun carriage ; tire nails, one pound to every 10 wheels ; copper nails for the implements, $\frac{1}{4}$ pound to each piece of cannon.

Iron axletrees $\frac{1}{30}$.

New irons of different patterns, about 60 pounds ; steel, 3 pounds ; sheet iron, $\frac{1}{2}$ pound ; tin plates, 3 pounds ; iron wire of different sizes, 2 pounds to each piece.

Note. The wars in which the United States have as yet been engaged, have called rather for artillery equipage fitted for the attack and defence of small posts and weak lines, than for the formidable preparations, the author has detailed as necessary for the siege or the equipment of great Fortresses. Yet the foregoing articles are not less interesting to an American reader on that account. The next war in which the nation is engaged, may, if offensive, terminate beneath the walls of Quebec or the Havanna ; or if defensive, witness the siege of the fortresses the wisdom of our government is providing in various parts of our extended frontier. For the attack and defence of lesser posts, the same principles will apply, as in great fortresses, and our officers have in more instances than one, distinguished themselves by a skilful application of them. None of these have been more honourable to the arms of the United States, than the defence of Fort Erie by General Brown. The British, who were repulsed in their attempt to carry that post by main force on the night of the 15th of August, sat down before it and commenced a regular siege. On the 17th of September, at which time they had completed their first parallel, opened two batteries from it, and had a third ready to commence its fire, General Brown ordered a sortie. The result of this was the capture and destruction of their works, and the artillery in them—depriving the enemy, in one hour, of the fruits of a month's labour ; and weakening his force in such a way that he was compelled to raise the siege.

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The sortie was directed against the right flank of the enemy's works, which were completely turned before the signal for attack was given. Much of the success of the action was due to the military skill with which this movement was combined by General Brown, his judicious choice of an unusual hour for the sortie, and the care with which the intended attack was concealed from the enemy. Up to the moment when the commands were distributed, no persons were admitted to his counsels, except General Porter, of the New-York Militia, and Lieut. Cols. M'Rea and Wood, of the corps of Engineers. These three officers greatly distinguished themselves in the action, and the latter died a soldier's death at the head of a battalion he had volunteered to command. Tr.

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PREPARATION OF THE AMMUNITION FOR CANNON AND SMALL ARMS.

CARTRIDGE is the generic English name for the package in which the powder, necessary for the charge of a gun, is enclosed, whether it be of flannel or other woolen stuff, or of paper, and whether the ball be attached to it or not. When the cartridge is of paper, it is called, in the French service, *gargousse;* if it be of woolen, *sachet;* and if the projectile be fixed to it, *cartouche;* the latter may be either made with a ball or with small bullets, and is the whole charge of a piece of artillery.

Of Paper Cartridges.

Paper cartridges are used in garrison and battering pieces; (they are also used for the sake of economy in the practical exercise of field pieces;) the paper ought to be strong and well sized; that which is 23 or 24 inches in height, and from 28 to 30 in breadth, will serve for any caliber, and cause less waste than if it were smaller.

The paper is cut in such a way, that when rolled round the wooden cylinder on which it is formed, it will overlap about 15 lines; the part that is to be folded over the bottom is also cut so as to project an equal distance. Paste is put upon this last part, and also upon one of the edges; the paper is rolled round the cylinder or former, the edges pressed together, and the hand passed over the part that is pasted; the bottom is put upon the end of the former, and attached to the paper cylinder by bending down the projecting part, which has several cuts made in it for the pur-

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pose : the finished case is taken from the former to dry it ; this is done upon a table, in the air. The former must have a hole pierced through it in the direction of its axis, so that the pressure of the air may not prevent the case from being removed without tearing. The bottoms ought to be circular, and of the same diameter with the former, they are cut out with scissars, or with a large punch.

The best paste is made of good flour boiled in water and mixed with a little strong glue.

Woollen Cartridges.

The powder is often enclosed in small bags of woollen stuff, that are used to contain the charges of field artillery ; woollen is better than any other kind of cloth, because it does not form a coal like linen, &c. ; and worsted stuff or serge has been uniformly found the best for that purpose. Twilled serge is not so good as that which is not twilled ; the latter does not stretch so much as the other, which often grows larger and spills the gunpowder. When untwilled stuff is not to be found, twilled may be taken, paying attention to cut the breadth of the bag in the direction of the length of the stuff. For want of serge, stuff that resembles it may be taken ; camblet will answer the purpose very well. (*Gassendi.*)

The colour of the serge is not indifferent ; gray is the best, then yellow, blue, red, white, in the order in which they stand ; black is to be rejected altogether, because the dye injures the quality of the stuff.

The bags are cut by patterns of a size equal to the circumference of the wooden bottom or shot stool, with the addition of four lines for the two edges of the seams ; the patterns for the circular bottoms of the bags are, one line and the whole breadth of the hems more in diameter than the lower part of the shot stool. The height of the patterns depends upon the proportion of the charge to the caliber.

In order to make the bag, a hem is laid on each side of the stuff and basted ; the two sides are then sewed together, with strong thread, to within two inches of the top, where the thread is fastened ; hems are made in the same way on the bottom and the lower end

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of the bag, which are joined by another seam; the bag is then turned, and the former forced in, upon which the seams are beaten down.

Before the bags are received, they ought to be examined to ascertain the goodness of the stuff, and whether they are of the proper size; the latter is done by passing them over a wooden cylinder of the size of the caliber; they ought to fit this without folds.

The bags may also be made without a circular bottom by continuing the hem round them like a sock; in this case, the flannel must be cut an inch longer than in the other.

Note. "In order to preserve stuffs, when in store, from worms, they should be steeped in water, to which a small quantity of arsenic has been added.

"To prevent the powder from sifting through the bags, and to protect them from the worms, they may be coated with the following composition: dissolve half a pound of glue in six pounds of water, and lay some of it upon the filled cartridge with a brush.

"If they are empty, stretch them upon a cylinder or a flat lapboard, and rub them with a brush dipped in spirits of turpentine; take them off to dry." (*Gassendi.*)

Of Shot Stools or Bottoms.

A shot stool or bottom, (*Sabot,*) is a cylinder of wood which serves to affix the ball to the charge of powder.* It has the advantage of preserving the gun, by preventing the ball from striking against the bore, and it, for the same reason, makes the aim more certain. When no wad is put into the gun, the ball if merely rolled in would fall out when the piece is depressed; it ought, therefore, to be retained by being attached to the cartridge or to the bottom.

If the ball do not fit the bore of the piece exactly, a bottom of the proper size would prevent it from being driven against the sides of the bore by the inflammation of the powder, the fire

* This method is only used for field pieces, on account of the expense and difficulty of providing a supply of bottoms for garrison and battering artillery.

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would become more true, and the range greater; on this account, the bottom ought to have less windage than the ball.

Shot bottoms should be made of hard and tenacious wood, and not of such as will easily break; for if it break in the bore, the ball will strike against the sides, and errors in the fire will be produced. The wood ought besides to be very dry.

The height of the bottom is about half the diameter of the ball; its upper surface is hollowed out a depth equal to one fourth of the diameter of the ball; its base is a little rounded, so that it may readily enter the woollen bag; and a groove is made 3 or 4 lines above this base to which the bag is tied. The ball is fixed to the bottom by two small bands of tin plate, that are called *lamettes* or hoops.

Shot bottoms are turned in a lathe; before they are received they are calibered and examined, after which 4 small grooves are made in them, diametrically opposite to each other, to receive the bands of tin plate that fix the ball to its bottom.

Three workmen ought to make 160 12 pounder bottoms in a day; one forms and cuts the wood, another turns the bottom and cuts the grooves, the third hollows out the place for the ball.

OF FIXING BALLS UPON THEIR BOTTOMS.

For this purpose, the following tools are needed: a large pair of shears to cut the tin plate into strips for bands, a smaller pair to cut slits in them, an awl to bore the holes, and a little hammer to drive the nails. The tin plate is cut into bands 4 lines in width, and of such a length that their ends may be fastened by nails, below the grooves; one of the hoops is slit in the middle, and the other passed through it in the form of a cross; a ball of the proper caliber is placed in the cavity of the bottom; one of the ends of the hoop that is not slit, is then fastened to the side with two nails; the first nail is placed in the groove, and the second between it and the lower part of the bottom; this hoop is then stretched, and nailed on the side of the bottom directly opposite; the same operation is performed with the other hoop, taking care that the cross is exactly upon the summit of the ball.

When the bands are nailed, if the ball is not held tight enough

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by them, they are sunk farther into the grooves to bring them to press closely upon it.

When howitzes are put upon bottoms, a border of tin plate, 7 lines wide, is put round the eye, and the bands are soldered to it.

The tin plate for the above purpose must be even, thin, and pliable.

The body of the nails for 12 and 6 pounders is 4 lines in length, and 3 lines for 3 pounders; the diameters of their heads are 3 and 2 lines.

MANUFACTURE OF BALL CARTRIDGES.

Fill woollen bags of the proper size, with the quantity of powder allowed to their caliber; shake the powder down and press it hard, by striking on the bag with the side of the hand; place the ball and its bottom perpendicularly in the bag, the bottom resting upon the powder; tie the bag tightly with an artificer's knot, to the groove in the bottom; then having folded back the top of the bag, tie it a second time over the powder immediately beneath and against the bottom: this second ligature completely prevents the powder from lodging between the bag and the bottom, where it might make a projection that would prevent the charge from entering the piece.

Each cartridge is passed when finished, through the gauge of its shot, which it ought to pass easily. This proof is essential to ensure that the ammunition shall be fit for service.

Twelve workmen are employed to finish the cartridges, as follows: 4 to fix the ball to the stools; one to fill the bags with powder; one to shake down the powder in the bags; 6 more, formed into gangs of two men each, to tie the bags to the bottoms; one of these two holds the cartridge, the second draws the cords tight by means of two little sticks, each of which is split at the end. These 12 men may make 250 cartridges in a day of 10 working hours.

CASE SHOT CARTRIDGES FOR FIELD PIECES.

For this purpose, old iron, broken balls, &c. were first employed, which were put into boxes. This was called firing with scrap, (*mi-*

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traille) or grape: pine-apple shot were next used; these were composed of 36 shot ranged in 6 layers, upon a stool of wood, from the middle of which a pivot projected; the balls were enclosed in a linen sack, one end of which was tied into the groove of the stool, the other to the top of the pivot; the whole was then wound round with 6 strands of twine, forming a net; but at present, experience has shown, that large bullets of wrought iron enclosed in a cylindrical case, are better than either of the others, and can be fired with more certain aim, and to a greater distance; no others are now used in the field service.

The tin cylinder or cannister, has the same exterior diameter as a ball of the same caliber; it is soldered up the side where the ends of the sheet overlap each other about 4 lines, and shut at the bottom by an iron stool on which the balls lie; the cylinder is closed at the top by a cover of sheet iron, which is held in its place by points $\frac{3}{4}$ of an inch in length, cut upon the upper edge of the cylinder, and bent down over the cover.

Stools made of the form of a spherical segment, and hollowed out, carry the balls farther than those which are flat.

To make a cannister of case shot, such as that which has been mentioned in the first volume, (article *Projectiles*,) place upon the stool at the bottom of the box, six large iron balls in the form of a circle, touching the side of the cannister and each other; fill up the interstice in the centre with smaller shot, then place a second row of large balls, each of which will lie in the interval between two of those below, and fill the centre with smaller shot as before; continue this until the 6th course, then lay on the sheet iron cover, and close the cannister by bending down the points cut at its top.

The case shot for 6 and 3 pounders and howitzers, is attached to the woollen cartridge, by a wooden bottom placed under the stool, to which it is fastened by nails. For calibers greater than 6 pounders, the case shot is not fixed to the powder, because they would then be too high to be placed in the caissons, and the weight of the cannister and its grape, would be apt to tear the bag. (The case shot cartridge weighs nearly one half more than the ball cartridge of the same caliber.)

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Note. It has been attempted to substitute plaster, poured among the bullets, to cement them together, in place of the tin cannister. In order to mould this kind of case shot, a tin box with handles is used; a wooden or iron stool is placed at the bottom of this box, having 4 pins projecting from it a distance equal to the diameter of one of the balls; the balls being placed as in the former case, liquid plaster is poured over them, and to a height of 4 lines above them; the box is then shut by a wooden cover 4 lines thick, pierced with holes so that the plaster may enter them and hold it on; when the plaster has set, the mould is opened and the cartouch wrapped in a strong cloth projecting a few lines at each end, where it is cut into fringes that are twisted into each other; it is fastened at the side in the same way. This sort of case shot is not as good as that which is in common use.

OF MUSKET CARTRIDGES.

In order to prepare these, there must be provided: 1st. Formers 7 inches long, and 1 line less in diameter than the bore of the musket; one of the ends of these are rounded, and the other hollowed so as to admit one third of the bullet. They ought to be perfectly cylindric, and of hard wood.

2d. Copper measures of the form of a truncated cone; the measure when heaped should contain the charge, which is half the weight of the bullet; for instance, if the musket takes a ball of 20* to the pound, the pound of powder will make 40 charges;

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* This is the size of the ball of the French musket. Formerly balls of 18 to the pound were used in the same musket, which made the fire more certain and the range longer; but the infantry are often obliged in service, to fire a great number of rounds without being able to clean their arms; the barrel then becomes dirty, so that if the cartridges were true they could no longer be driven in at all, or without difficulty; it has, therefore, been thought proper to give more windage to the ball, and make it 20 to the pound.

As the cartridges of the carabine and pistol must fit the bore, in order that they may not fall out of the barrel when it is turned upside down, as it must be when carried by a horseman; the caliber of these arms has been a little diminished, in order that it may not be necessary to provide larger balls for them than for the musket, which would have complicated the supplies, and occasioned a risk of mistake in making distributions to the army.

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the number of charges for a pistol is $\frac{5}{8}$ more to the pound than the musket, so that a pound of powder will make 65.

3d. Paper of a strong body, yet at the same time not too thick, and of a suitable size. That which is 13 inches high and 16 in length cuts without waste; each leaf furnishes 12 cartridges.

4th. Tables, in the thickness of which are cut holes, whose diameter is a little greater than that of the bullet, and their depth about one third of that quantity; the use of these is to smooth the folds of the cartridges. The men are divided into gangs of ten each, of whom 6 roll the cartridges, 2 fill them, and 2 bundle them up. Such a gang may make 10,000 cartridges in a day.

There should be a particular workman to cut the paper for all the gangs. He takes 4 or 5 sheets of it at a time, folds them in three, in the direction of the length, and cuts them along the folds; he then folds each of these thirds into two, the other way, and cuts them; finally, he cuts these last pieces also into two, but with a diagonal line, beginning about $2\frac{1}{4}$ inches from the upper angle or the left, and ending at the same distance from the lower opposite angle on the right; in this way each leaf is cut without loss into 12 little trapeziums, out of each of which a cartridge is made.

The paper cut in this way is handed to the workmen entrusted with rolling the cartridges; they are placed round a table opposite the little holes cut in it. Each workman lays his paper before him, the long side parallel to the edge of the table; he holds the former in one hand, and places a ball in its cavity, then lays the former on one of the little trapeziums, the ball towards the largest side, and the paper projecting half an inch beyond it; he rolls up the former and the ball, in the paper, pressing it hard with his hand; then raises the end of the former so as to wrap the excess of paper over the ball, beginning with folding on the acute angle. He then places the end of the cartridge in the little cavity, leans forcibly upon the former, and turns it round and round to smooth and press down the folds over the ball.*

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* Cartridges are sometimes made with three buckshot under the ball; these are valuable when the action is close, as they wound more men, and the smallest wound causes them to quit the ranks.

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Before the powder is put into the cartridges, they are tried in the muzzle of a musket of the true caliber, and those that are not of the proper dimensions rejected.

The men that fill the cartridges are each provided with a little keg, about 8 inches high, containing powder, and 2 half kegs, each 5 inches high, within, to hold the empty cartridges, that are arranged vertically in them; they have also, each a powder measure, and a small funnel. These men place themselves at the end of a table with those whose duty it is to bundle them up; the keg and half kegs arranged near each other; they then pour a measure of powder into each cartridge with the funnel.

When a half keg of cartridges is filled, it is passed to the men who bundle them up; these flatten the end of the paper of each cartridge, by pressing it between their finger and thumb, and form a second fold by doubling in the superabundant paper, in the direction of the length of the cartridge. When this half keg is exhausted, they put empty cartridges into it, and place it near the powder keg; the work is continued in the same way. There are 10 cartridges in each bundle, the balls placed alternately up and down; each bundle is wrapped up in a half sheet of paper, and tied with twine. These bundles are packed in cases or barrels, in which they may lie in the magazine or be transported. (*Hulot.*)

A sheet of paper will make 12 cartridges, but as loss may take place, no more than 10 are reckoned on; half a sheet is required to pack them; so that for 1,000 cartridges, 150 sheets or $6\frac{1}{4}$ reams of paper will be wanted, along with 5 ounces of twine.

Note. For blank cartridges intended for drill, the paper is folded into four instead of three, and 16 cartridges are then obtained from it; in this case, the charge of powder is one sixtieth of a pound.

Manufacture of bullets. A single man may pour and dress two cwt. of bullets in a day; but in order that the work may go on better, the men should be divided into gangs of 5 each; these will easily run half a ton in one day: one man pours, two withdraw the moulds and stir the fire; two cut off the *gates*, and roll them in a barrel to trim off the barbs.

For three gangs, two small iron kettles are needed of a foot in

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diameter and nine inches deep. The three moulders stand before the kettles, in one of which the metal is in a state of fusion, while it is melting in the other.* The other workmen are behind these.

The tools are 3 spoons to each kettle at work. (1 to each gang.)
18 moulds of 20 balls each. (6 to do.)
3 benches for the moulders. (1 to do.)
3 gauges.
6 pair of shears to cut the barbs from the balls. (1 to do.)
2 barrels to roll the balls.

All the balls that have flaws and air holes, or are too large, must be rejected.

As the weight of balls has a great influence upon the extent of their range and the certainty of their fire, nothing ought to be employed in their manufacture but well purified lead. The fracture of this is of a dull bluish white.

Gun flints. Are made usually of nodules of flint, but other silicious stones will answer the purpose; the best are transparent and without spots. Agate, Cornelian, and Chalcedony, may be used, but their hardness soon destroys the face of the hammer.

A good flint will stand 50 rounds without being unfit for service, so that a supply of one for 20 rounds may be considered amply sufficient; however, one is tied up with each bundle of cartridges. They are packed in barrels of 25,000, which weigh about 700 pounds.

RECAPITULATION OF THE ARTICLES NECESSARY FOR PREPARING AMMUNITION.

Balance and weights.
Benches for the workmen.
Barrels to hold powder.
Shears to cut the hoops for fixing shot on its bottom.

* Two kettles are enough when the lead is in old balls, or scraps, but 4 are needed when it is in pigs.

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Smaller shears, to slit the hoops.
Nails to fasten them.
Knives.
Funnels to fill musket cartridges.
do. to fill gun cartridges.
Gauges to examine bottoms, stools, formers, cartridges, balls, &c.
Formers for musket and gun cartridges.
Hammer to fasten the bottoms.
Powder measures of copper for musket cartridges, &c.
Cartridge paper.
Awls to bore tin plates.
Glue and paste pots and brushes.
Tin cannisters for case shot.
Gunpowder.
Projectiles.
Woolen bags; or stuff, thread, needles, and patterns to make them.
Implements for making musket bullets as above described.
Twine.
Tin plates.
Tables for the workmen, brooms, and brushes.

OF PILES OF SHOT, HOWITZES, SHELLS, AND GRENADES.

In order to make a pile of these projectiles; level the ground, take out any stones that may be on its surface, and make it firm; mark with a cord the direction of one of the sides of the pile, and if it is to be rectangular, determine one of the sides perpendicular to the first, by means of a square; first place a ball at the right angle and fix it well; then place two others to mark the direction of the sides, and a third, within the base, at some point taken at will; these three balls, thus provisionally placed, will serve as points by which to level each side with the ball at the angle; place balls touching each other along the two sides, level them by the three placed for that purpose, and make them steady in their places by striking them gently with a mallet. (In order to level the balls, a ruler two or three yards long, and a masons level are needed;) as soon as a ball is placed, lay the ruler in such a way as

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to bear upon it and the directing ball in the prolongation of that side, then lay the level upon the ruler, and it will be seen if the ball must be raised or lowered, this levelling is verified by the third ball which is placed in the interior; perform this operation for every ball that is placed on the two sides of the base: then lay rows parallel to these, which must be levelled and steadied in the same way, until the base is finished. Place the next course of balls in the interstices of the first, and so on.

If the base is to be triangular, it is only necessary to fix the direction of one of the sides, the other two are formed by placing a second row of balls parallel to the first, in such a way that each ball of the second row leans against two balls of the first; each row thus laid will have one ball less than that before it, until the last, which will be of only one ball, and will determine the third angle of the equilateral triangle that the base will form.

Of calculating the number of Projectiles in piles.

There are three sorts of these piles, the triangular, which is a pyramid, whose base and the faces are equal and similar triangles; the square pile, whose form is that of a pyramid, the base of which is a square, and the sides equilateral triangles; and the oblong pile, whose base is a rectangle, and the form that of a prism.

Triangular Pile. In order to find the number of balls in this pile, the number of balls on one of the sides of it increased by unity, must be multiplied by the same number with two added to it; this product is to be multiplied by the number of balls in one of the sides, and the sixth part of the product is the number required. This rule is represented by Bezout's formula.

$$\frac{n \times (n+1) \times (n+2)}{6},$$

in which n is the number of balls on one of the sides.

Square Pile. In order to find the number of balls in this pile, take the product of one of the sides into the side increased by unity, and multiply it by twice the length of the side also increas-

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ed by unity; take the sixth part of this last product. The formula is $\frac{n \times (n+1) \times (2n+1)}{6}$.

Oblong Pile. In order to find the number of balls in this pile, the number of balls in one of the sides of the triangular faces must be multiplied by $\frac{1}{3}$ of the sum of the three parallel edges. In order to find the number of balls in the triangular face, multiply the number of balls on one of the sides of this face, by the same number increased by unity, and take half the product. The formula is $n \times \left(\frac{n+1}{2}\right) \times \left(\frac{m+2) \cdot (m+n-1;}{3}\right)$ n is the small side of the base, and m the upper edge.

To find the Dimensions of a Pile.

In order to form piles of a given number of projectiles, if it is a triangular pile, multiply the given number by 6, and extract the cube root of the product, which will be the number of balls in the side. If it is for a square pile, multiply the given number by 3, and extract the cube root of the product, which will be the number in one of the sides of the base. The oblong pile may be considered as composed of a square pile, and a prism, whose sides are equal, and which is no more than a succession of triangular plates; an oblong pile may be calculated by first calculating the size of a square pyramid, the rest of the balls must be divided by the number of one of the triangular faces, in order to find the number of shot in one of the sides of the prism. For more ease in calculation, consult the following table.

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TABLE, showing the number of projectiles contained in a square or oblong quadrangular pile, as far as a base of 20 by 20, that will also serve to compute the sides of piles when the number of projectiles are given.

The figures along the left side of this table and those on the diagonal on the right side, show the number of projectiles that form the sides of the base of the pile. Each number inscribed in one of the squares is the total amount of projectiles contained in the pile which has, as the sides of its base, the numbers of the left side and of the diagonal whose columns cross upon the square in which the number is placed; thus if the two numbers that are found to form the sides of a given pile be sought in these two lines, the number of balls in the pile will be found in the common tersection of the columns under these figures.

In order to construct a pile with a given number of projectiles, seek this number in the table, or that which is nearest to it; the numbers that correspond to this in the left hand column and the diagonal, are the length that must be given to the sides of the base.

1	2																		
2	5	3																	
3	8	14	4																
4	11	20	30	5															
5	14	26	40	55	6														
6	17	32	50	70	91	7													
7	20	38	60	85	112	140	8												
8	23	44	70	100	133	168	204	9											
9	26	50	80	115	154	196	240	285	10										
10	29	56	90	130	175	224	276	330	385	11									
11	32	62	100	145	196	252	312	375	440	506	12								
12	35	68	110	160	217	280	348	420	495	572	650	13							
13	38	74	120	175	238	308	384	465	550	638	728	819	14						
14	41	80	130	190	259	336	420	510	605	704	806	910	1015	15					
15	44	86	140	205	280	364	456	555	660	770	884	1001	1120	1240	16				
16	47	92	150	220	301	392	492	600	715	836	962	1092	1225	1360	1496	17			
17	50	98	160	235	322	420	528	645	770	902	1040	1183	1330	1480	1632	1765	18		
18	53	104	170	250	343	448	564	690	825	968	1118	1274	1435	1600	1768	1938	2109	19	
19	56	110	180	265	364	476	600	735	880	1034	1196	1365	1540	1720	1904	2091	2280	2470	20
20	59	116	190	280	385	504	636	780	935	1100	1274	1456	1645	1840	2040	2244	2451	2660	2870

TABLE

FOR TRIANGULAR PILES.

Size of the triangle.	Number of projectiles on the face.	Whole number.
2	3	4
3	6	10
4	10	20
5	15	35
6	21	56
7	28	84
8	36	120
9	45	165
10	55	220
11	66	286
12	78	364
13	91	455
14	105	560
15	120	680
16	136	816
17	153	969
18	171	1140
19	190	1330
20	210	1540
21	231	1771
22	253	2024
23	276	2300
24	300	2600
25	325	2925
26	351	3276
27	378	3654
28	406	4060
29	435	4495
30	465	4960

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MILITARY FIREWORKS.

MILITARY FIREWORKS are, for the most part, articles prepared to set and communicate fire.*

THE LABORATORY.

A firework laboratory ought to consist of a large hall, in which are placed the workmen, with tables, benches, and closets, where the tools, paper, thread, &c. may be commodiously placed; and of a smaller room to contain a supply of materials for two days work, in which the chief artificer may take their weight, make up the compositions, and keep an account of them. The prepared fireworks ought to be removed daily to the magazine; or if the laboratory is (as usual in the field) under a tent, they should be packed in barrels, or in park caissons provided for the purpose.

Utensils to be provided.

Copper rods, to load port fires, and the fuses of shells, howitzes, &c.
Wooden formers, to roll the paper cases of port fires upon.
do to roll the cases of rockets.
Balances, large and small, with scales, weights, &c.
Buckets, to carry water.

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* This summary of the construction of Military Fireworks, is taken from the treatise of Major Bigot, of the French Artillery.

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Boxes, for loading priming tubes.
Barrels, with leather tops that draw, in order to keep grained and meal gunpowder.
Rods, for loading rockets.
Brushes, to wipe the tables, and sweep the compositions together.
Frames, to dry priming tubes.
Copper calibers, to regulate the size of priming tubes.
Penknives.
Needles for piercing priming tubes in the direction of their length.
Fuse drivers.
Coopers' adzes.
A copper kettle.
Scissars for cloth and paper.
Paper cutters.
Priming wires.
Skimmers for skimming the froth of boiling saltpetre.
Funnels for charging port fires, howitzes, shells, &c.
Square ruler.
Forge for shells, &c. (or a lathe to make them.)
Large and small wooden bowls.
Small axes.
Ladles for charging the fuses of shells, port fires, &c.
Mallets to hammer the fuses.
Glue pots and brushes.
Heavy mallets to beat the powder.
Tin measures of different sizes.
Hand mortar.
Foot rules.
Rat-tail files to cleanse the interior of the reeds of priming tubes.
Wooden rasps.
Iron rulers $\frac{1}{2}$ foot long.
Leather bags, in which gunpowder and charcoal are reduced to powder.
Pocket saws.
Pallet knives for the saltpetre.
Tables, small ones to mix the composition, large ones with a ledge to meal the powder on.
Sieves, fine and common, of silk and of hair.

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Fuse drawers.
Tools for rolling cartridges.
Gimblets of different sizes.

Materials.

Gunpowder.
Saltpetre.
Sulphur.
Charcoal.
Camphor.
Bees-wax.
Glue.
Rosin.
Cotton yarn for quick match
Brandy, or other spirits.
Gum Arabick.
Linseed oil.
Spirits of turpentine.
Turpentine.
Pitch.
Reeds or quills for priming fuses.
Mutton tallow.
Vinegar.
Thread for tying quick match.
Cartridge paper.
Thread.
Tow and spunyarn, to make match rope.
Cordage to make tourteaux.
Flour to make paste.

PREPARATION OF THE MATERIALS.

The chief ingredients of fire-works, which are gunpowder, saltpetre, sulphur, and charcoal, ought to be reduced to powder in order to prepare them for use.

To reduce gunpowder into meal or dust, it is bruised upon a table of hard wood, surrounded by a ledge of two inches in height, with a spout upon one side to pass the powder into sieves; the

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muller is six inches in diameter, and has a handle, of suitable thickness, seven inches in length. The meal is passed through a sieve with a double drum.

There is a method of reducing powder to dust more expeditious, less subject to accidents, and less troublesome in the field; this is to employ a leather sack that will hold about 20 pounds, well sewed, drawn together at the opening, and fastened by cords; one man holds it upon a block of wood, while another strikes it with a cylindrical mallet, until the powder is reduced into meal, fine enough to pass through a silken sieve.

In order to reduce *saltpetre* into dust, it is put into a kettle* and covered with two finger-depths of water, or two pounds of water are added to six pounds of saltpetre; it is first dissolved over a slow fire, and afterwards boiled, during which operation, three or four pinches of powdered allum are thrown in to make the filth rise, which is scummed off. When it begins to thicken, it is stirred with iron spatulæ; the fire is diminished little by little, and the stirring continued until the whole assumes the appearance of fine flour. It is then taken out and permitted to cool; afterwards passed through a hair sieve, and kept for use in a dry place.

In order to obtain chrystalized saltpetre, it is melted in a very small quantity of water, withdrawn from the fire as soon as dissolved, and permitted to cool.

Saltpetre of a good quality ought to be, before it is reduced to powder, pure, hard, transparent, and well separated from the extraneous salts it may contain.

The *sulphur* made use of in fire works, ought to be of a lemon colour, and very clean. If it is not in this state, it is melted over a slow fire, in a glazed earthen vessel, or in a copper kettle; it is skimmed, and passed through a linen sieve. In order to reduce it to fine powder, it is ground in a mortar, and passed through a silken sieve.

The *charcoal* ought to be made of a light wood, (willow or

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* Forty pounds of saltpetre is a very convenient quantity for operating upon; it requires a kettle fourteen inches high and twenty in diameter, made of copper, in preference to any other metal.

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poplar,) as it will then take fire more readily. It is reduced to powder by beating it in a mortar, then passed through a coarse hair sieve, and afterwards through a finer one.

OF SLOW MATCH.

The rope for this match is usually made of flax, or if it cannot be had, of soft well beaten hemp, thoroughly cleansed from the harder fibres; the strands are spun without being hard twisted. Match is of three strands, and ought not to be more than 20 lines in circumference; it should not be shortened, in twisting, more than one fifth or one fourth at most, in order to be firm without being hard.

Matches are boiled in lye for 15 hours; (each 100 pounds of match takes 50 pounds of ashes and 25 of lime;) they are then taken out of the tub, piled in heaps, and covered with tow; in which situation they are left twelve hours to ferment.* They are afterwards polished, by rubbing along the whole length a hair cord, or something of that sort, to cleanse the match of the fibres that may remain upon its surface, and which spread fire too rapidly. It is a good plan to twist the match strongly, before it is polished, in order to make it firm.

Matches are, last of all, dried in the sun, and rolled into pieces of 20 yards each, (weighing about 2½ lbs.) then made up into barrels or boxes, each of which contains about 20 of these pieces.

If the match be all used, it may be quickly replaced by the following process.

Put water (rain water in preference) into a kettle over the fire; when it begins to boil, throw in sugar of lead, at the rate of three fourths of an ounce to a pound of water; take it off in about five minutes after, which time is necessary to dissolve it; bathe the cords, you wish to make match of, in this bath for the space of ten minutes; then take them out and dry them in the air.

Match may be made with cold water; in this case the cords

* The matches, after being dipped in lye, may be improved by immersing them three or four times in water, where four pounds of saltpetre to every 100 pounds of match is dissolved.

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ought to remain in the solution of sugar of lead six hours, in order that they may imbibe it as completely as they do the hot solution.

All sorts of cords, whether old or new, even those made of the linden bark, and damaged match, may be submitted to this operation, taking the precaution to boil them first in common water to remove their old coating. One pound of solution is required for each pound of cord.

Match of a good quality, burns uniformly at the rate of five inches per hour, and its coal terminates in a point that resists pressure.

PORT FIRES.

Port fires are a species of fuse of a slow composition, that are used as matches for guns when they are to fire rapidly. In order to make them, there are required, a rod or mandril of hard wood 16 or 18 inches long, and $5\frac{1}{2}$ lines in diameter, to roll the paper cases upon; two brass rods to load them, one 17 inches in length, the other only 8;* a small funnel with a spout, $5\frac{1}{2}$ lines in diameter; a ladle of any convenient size to lift the composition in; white paper well sized, and some other articles we shall describe hereafter.

Construction. Cut the paper into bands $3\frac{1}{2}$ or 4 inches wide, and 15 inches long; arrange 6 strips of this paper, on a level table, one above the other, in such a way that each strip extends about half an inch beyond that next below it; put a small quantity of paste upon the projecting parts of this paper; place the wooden rod upon the upper strip, near the end; roll the paper round it several times, pressing it with both hands; shut it at one end, by bending the paper up 3 or 4 lines on the rod, and striking it on the table to flatten it; take out the rod and dry the case.

In order to charge it, the spout of the funnel is introduced into one end of the paper case; the copper rod inserted, some of the composition put into the funnel, and rammed as fast as it

* For want of a copper rod, a wooden one may be used, but then it ought to have a head at least two inches long and one inch in diameter to make it heavier.

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falls down, which is done by alternately raising and lowering the copper rod without drawing it entirely out. Care must be taken to beat it uniformly, with such a force that the paper may not be torn, and that the composition may be equally solid throughout its whole length.

When the composition is within an inch of the end of the paper case, a tow match is put over it, of $1\frac{1}{2}$ inches in circumference, the two ends of which project from the paper case; it is then covered with a paste made of meal powder and gummed spirits of wine.

The port fire is finished by pasting upon its end a small bit of paper that is bent down upon the case on each side, and torn off when the match is to be used.

Port fires are tied up in a sheet of paper, in parcels of ten.

Composition of Port Fires.

parts of	Meal Powder.	Saltpetre.	Sulphur.	Charcoal.	Rosin.
To last 12 minutes, moistened with linseed oil,	10	12	6		
10 do. do.		$19\frac{1}{2}$	$7\frac{1}{4}$	$\frac{1}{2}$	
7 do. (commonly used.)		$19\frac{1}{2}$	8	$\frac{1}{2}$	$1\frac{1}{2}$

Port fires of the first composition burn with least violence, and are therefore more subject than the others to be extinguished by rain.

The articles having been weighed, are mixed by passing them through fine sieves at least twice; when they are to be moistened with linseed oil, the composition is again mixed with the hand, until it set among the fingers. (If too much oil be added, the port fire will not keep.)

Fourteen pounds of composition, and $2\frac{1}{2}$ reams of paper, are required for 100 port fires.

PRIMING TUBES.

Priming tubes, (*fusées d'amorce,*) serve to communicate fire to powder placed in the bore of cannon. They are composed

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of two distinct parts, the fuse that enters into the touch-hole, and a small match called the *cravat*, which projects to receive the fire from the portfire or match intended to communicate it. These tubes are made of small pieces of well dried reeds, or of quills, a little less than the size of the vent of the piece. They have also been made of paper, and have stood service.* If reeds are used, they should be cut in winter.

Construction. The reeds are cut into pieces three inches in length, square at one end and diagonally at the other; they are then passed through a caliber 2½ lines in diameter; (the diameter of the vents being 2½ lines;) they are rubbed clean in the inside by passing a small file several times through them, that removes the inner skin. The reeds thus prepared, quills or other cases are filled with the composition we shall describe, made up into a paste sufficiently liquid to enter them. The most simple and expeditious method of doing this, is to place the cases, side by side, with the square end up, in a tin or wooden box 5 inches deep; the composition is put into this and made to descend into the cases, by knocking the box smartly upon a table. When they are full they are taken out of the box, wiped clean, and laid to dry in the sun or in a warm room; before the composition is entirely dry, a knitting needle is passed from one end to the other, in order that the fire may reach the bore of the piece more rapidly; the match of communication, (called *etoupille*,) is then fixed; this is done by cutting a notch on each side of the reed, near the end that is cut square, to which two strands of a match, 2½ inches long, are tied with a fibre of hemp.

The tubes are tied up in packets of ten each, to facilitate their distribution in service.

The reeds, or other cases, may also be filled in the following way, viz: Take twine made of three strands of cotton thread, and cut it into pieces 10 inches long, fold each of these into two lengths and pass them through the reed from one end to the other by

* Tin plates are subject to the inconvenience of rusting, and spoiling the composition with which they are charged.

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means of a loop of very fine thread; the two ends are covered with some of the composition made thick.

Composition of Priming Tubes.

parts of	Meal Powder.	Saltpetre.	Sulphur.	Charcoal.
Usual composition, moistened with spirits,	12	8	2	3
Very quick composition, do.	4	1		

In order to moisten these materials, an ounce of gum-arabic, and half an ounce of camphor, must be dissolved in a pint of brandy or other spirit.

These articles should be mixed by hand, and then passed through a fine hair sieve to complete the composition.

Fifteen pounds of it will make ten thousand tubes.

Of Quick Matches.

Priming tubes, as well as all other fuses, and every kind of firework, are furnished with small quick matches, (*etoupilles*,) to communicate fire to them more readily.

These matches are made of 5 strands of fine cotton thread, soaked 24 hours in strong vinegar; (or if time presses two or three in brandy or other spirit;) they are then put, for 12 hours at least, in a liquid paste, made of meal gunpowder, and spirits, in which gum-arabic and camphor are dissolved, in proportions we shall hereafter detail; to make them imbibe this completely, they are pressed with a pallet knife; they are then taken out and drawn gently between the fingers to discharge the excess, spread upon a table, and when half dry dusted with meal gunpowder; the match is rolled by hand to make it round, hung upon a frame furnished with pins to dry; it is afterwards cut into lengths of 2½ feet, and tied up in bundles to be kept or distributed.

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Materials necessary to make 10,000 *Priming Tubes.*

Cotton thread, 5 lbs.
Meal gunpowder, 3 do.
Vinegar, 5 quarts.
Brandy, or other spirits, 3 quarts.
Gum Arabic, 3 ounces.
Camphor, $1\frac{1}{3}$ ounces.

In order to procure matches to communicate fire slowly, meal gunpowder is needed, to which sulphur and bees-wax must be added according to the degree of slowness required; in this composition the cotton must have been soaked in water instead of spirits.

FUSES FOR SHELLS, HOWITZES, AND GRENADES.

These fuses, intended to communicate fire to the powder with which these shells are filled, so as to make them burst in the places to which they are thrown, are made of wood turned to the form of a truncated cone, in order to enter fairly into the eye of the shell. They are perforated through the middle, in the direction of the axis, so as to receive the incendiary composition. This channel is called the light of the fuse. The wood that is employed should be strong, dry, sound, and without knots; the best kinds are the oak, the elm, and the linden.

The fuses for 10 and 12 inch shells are $8\frac{1}{2}$ inches long; for 8 inch shells, $7\frac{1}{2}$; for howitzes, $5\frac{1}{2}$, and $2\frac{1}{2}$ for hand grenades. The diameter of the light, in the first, is 5 lines, in the second and third, 4 lines, and 2 lines for grenades. At the larger end of the fuse for shells and howitzes, a cup is made from 10 to 14 lines in diameter, and three deep. In turning them, a solid bit $2\frac{1}{2}$ inches thick, is left at the small end, to prevent them from splitting when the composition is pressed into the canal. When the fuse is driven into the eye of the projectile, this piece is sawn off, cutting the fuse diagonally. The turner marks its termination by a circle upon the fuse.

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Method of Charging the Fuses of Bombs.

Two rods, or rammers, of copper, are needed for each of the several calibers of 12, 10, and 8, inches, the first an inch longer than the fuse, the second half as long. These rammers are of the same diameter with the lights of their respective fuses, and have a head to receive the blows of a mallet; only one rod is wanted for the fuses of smaller calibers.

The first operation is to examine the fuses, to see that they have no knots or flaws, and that they are not worm eaten. The artificers place themselves astride, and facing each other, upon benches of strong plank, having, between them, a small vessel filled with the composition, and each, a small measure; each artificer takes a fuse, inserts the small end into a hole made in the bench, for the purpose of maintaining it erect, and preventing it from splitting when in the act of charging; he then pours a measure of the composition into the light, and introduces the first rod, on which he strikes 15 strokes, of equal force, with a mallet; between every three strokes, he raises the mallet to make the composition fall; the ramming of this measure is, therefore, executed in 5 *volleys*, of 3 strokes each. He then withdraws the rod, and introduces a new charge of the composition, which he beats as before, and so on until the fuse is half full, after which he makes use of the second rod, and goes on loading, until the charge reaches within three lines of the cup; he then takes two strands of quick match, which, (after placing them in the form of a cross, on the top of the fuse,) he presses in with his rod, pours some of the composition upon them, and beating it carefully, so as not to cut the match, he fills the fuse to the top of the cup.

The fuses of howitzes and grenades are charged in the same way, but the blows are not so heavy as in larger ones, for fear of splitting the wood.

The fuses being thus charged, the quick match is folded into the cap, and the opening closed with a bit of cloth or parchment that is tied an inch below the top; this is called *capping* the fuse.

To preserve fuses in store, and protect them from moisture, the cap is coated with a composition made of 16 parts of bees-wax, and 4 of mutton tallow. These are melted together, the cap of

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the fuse is dipped into them when half cold, and immediately withdrawn.

Composition for the Fuses of Shells, Howitzes, and Grenades.

parts of	Meal Powder.	Sulphur.	Saltpetre.
Composition usually employed,	5	3	2
Quicker composition,	7	4	2

The composition ought to be well mixed with the hands, and then passed twice through hair sieves.

It is rendered quicker by adding meal-gunpowder, and slower by adding sulphur.

These fuses burn both under ground and in the water; those described above for 12 and 10 inch shells last 70 seconds. To charge a thousand fuses for 12 and 10 inch shells, 92 pounds of the composition are required; for as many 8 inch shells, 53 pounds; for as many howitzes, 37 pounds; and for as many hand-grenades, 16 pounds.

Manner of Loading Shells, Howitzes, and Grenades.

Before these projectiles are loaded, all the earth, water, and other matters that may be in them, are emptied out; those that are split are rejected, as are those whose eye has flaws in it, is not well bored, or is eccentric; these are then charged with powder, introduced into them by means of a funnel.

Five or six pounds of gunpowder are usually put into 12 inch shells; from 3 to 5, into 10 inch shells; from 1 to $1\frac{1}{4}$, into 8 inch shells; from $\frac{3}{4}$ to 1 pound into howitzes; grenades of all sorts are half filled. The charge of shells is increased when they are wished to burst into a great number of pieces; for instance, when they are to fall among troops. Incendiary fireworks are added, when buildings are to be set on fire; among these are fire stone, and incendiary matches.

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The charge having been put into these hollow projectiles, a fuse is introduced into the eye, after it has been cut diagonally at the smaller end, and the solid part taken off; it is forced in by repeated blows of a mallet on the fuse driver, which is laid upon the cap of the fuse; it ought not to project more than 8 or 10 lines in shells, and 6 or 7 in howitzes.

The fuses of loaded shells, howitzes, and grenades, are preserved from wet and fire in the field, by dipping that part of the fuse which projects from the surface of the sphere, into the following composition. (The immersion is performed when the articles, after having been melted together, are again half cold.)

Pitch, . . .	31 parts.
Turpentine, . .	16 do.
Mutton Tallow, . .	1 do.
Linseed Oil, . .	6 do.

OF SIGNAL ROCKETS.

A rocket is a cylinder of pasteboard filled with fireworks, which is raised into the air by means of the reaction of the column of fire, that issues from it, upon the column of air beneath it. Rockets are employed in war to give signals; thus they point out the time to make an attack in concert, give intelligence of the arrival of succour, &c.

The outer diameter is usually from $1\frac{1}{2}$ to 2 inches, the length of the charge 5 times, and the interior diameter $\frac{2}{3}$ as much as the exterior.*

In order to construct them, the following tools are required: a rod, or former of wood, to mould the case upon, and an artificer's tool to roll the paper close;

A conical spit, by means of which the rocket is loaded, in such a way as to have a hollow through the middle, that augments the surface of the composition; this spit should be $4\frac{2}{3}$ times as

* I do not speak here of Congreve Rockets, whose case, made of sheet iron, is 3 1-2 inches in diameter, and 28 in length; the composition is the same as in the above, but the pot, which is one third of the whole length of the rocket, is charged with fire stone, or small grenades; this rocket weighs 22 pounds, and its range is at least 4,250 yards.

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long as the outer diameter of the rocket, $\frac{1}{3}$ of this diameter at the base, and $\frac{1}{8}$ at the small end ;

Three rods for loading, with a conical aperture to receive the spit ; the first has it large enough to take in the whole length of it ; the second to take in $\frac{2}{3}$ of it, and the third one third only. They ought to be furnished with a copper button at the end, firmly fixed to the wood to prevent them from splitting when struck ; they have each a head so as to be held easily while the mallet is in the act of striking ;

A rod, not pierced, to charge the solid part, that begins at the end of the inner cavity formed by the spit ; this solid part ought not to be higher than two thirds of the exterior diameter. (If the rocket is no more than an inch in diameter on the outside, the solid part ought to be as high as it.) These three rods are each of them a line less in diameter than the inside of the rocket case ;

A ladle, or measure, whose diameter is equal to that of the inside of the rocket, and its length three times as much.

The following compositions are used to charge rockets.

Parts of . . .	Meal powder	Saltpetre	Sulphur	Charcoal
Composition, . . .	$1\frac{1}{2}$	17	$3\frac{1}{2}$	8
Do. for particular purposes,		16	4	9

When the meal gunpowder, saltpetre, and sulphur, have been separately sifted, they are mixed by passing them three times running through a second hair sieve ; the charcoal is then added, which has been only once sifted, and the mixture completed with the hand.

To construct the cartouch, case, or paper cylinder—strong paper is employed, of which pasteboard, three leaves in thickness, is made, and two inches longer than the solid part of the rocket, taking care that each leaf projects beyond the other about five lines. A sheet of this is rolled upon the rod or former, making use of a tool, made for the purpose, to press it as close as possible ; to the extremity of this sheet another is presented, and pasted to it over its whole surface ; it is rolled in the same way as the other, and this process is continued until the case has attained the proper

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size; it is then taken from the former, and laid to become half dry, when it is tied up, or, as it is technically termed, *choked*.

The case of a rocket is *choked* by means of a piece of cord three lines in diameter, one end of which is firmly fixed into a wall, and the other tied to a stick, against which the artificer, who bestrides the cord, rests. The cord is soaped, and two rods are introduced into the case, that for ramming the solid part, at one end to the depth of an inch only, and the former at the other end, until it nearly meets the first. The artificer puts two turns of the rope round the cartouch between these rods, then leans back, and by pressing with his weight upon the stick, chokes it, leaving a neck, or passage, the diameter of which is only one half of the greatest diameter of the spit; it is fixed by several artificer's knots; the case is then dried and cut to the proper length.

To load a Rocket.—Place the spit vertically in a block of wood, soap it, and introduce it into the neck of the case by means of the first rod, which is pushed in on the other side, and struck with a mallet until the case passes over the spit and meets the block of wood; draw out the rod; put so much of the composition into the case with a ladle, as when well beaten, will occupy the space of half an inch; introduce the rod again, and give a few strokes of the mallet to settle the composition, after which ram it down with 24 strokes of a mallet, whose size is four inches by five; introduce a second charge, ram it in the same way as the other, and continue this until the case is one third full; then take the second rod and ram with it until the case is two thirds full, after which the third must be employed, which will carry the charge to the exact height of the spit; finally, the solid rod must be used to fill up the remainder, which extends the thickness of two thirds of the exterior diameter above the spit.

Finish the rocket by putting a circular piece of pasteboard upon the top of the charge; double down upon this, the part of the case that projects, and which ought to be two thirds of the exterior diameter; press it upon the pasteboard with blows of the stick; pierce three holes through this heading to communicate fire to the trimming, which consists of petards, stars, or serpents, in order that the rocket may be heard or seen at a great distance.

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This is put into another paper cylinder, named the *pot*, and fastened on the top of the rocket.

The pot is made of a pasteboard, three sheets of paper in thickness, and rolled upon a former, having parts of two different diameters; that which is greatest and forms the body of the pot, has a diameter one half greater than the exterior diameter of the body of the rocket, and a height of one and three fourths of that dimension; while the other part, called the *douille*, or handle, has a diameter equal to that of the outside of the rocket, which it receives, and is pasted to it, while its height is the half of its breadth; the top being rolled upon its former is to be choked, the end of the rocket inserted, fixed by a few turns of thread, and covered with pasted paper; throw a few grains of powder into the bottom of the pot, to communicate fire to the trimming that is put into it, and surmount the whole with a conical cover, to pierce the air, and facilitate the flight of the rocket.

This cover is made of thin pasteboard, its height is one half more than the exterior diameter of the rocket, and its base the same as that of the pot, to which it is fixed by pasting a band of paper over both.

The rockets being entirely finished, are primed with a piece of quick match, about eight inches in length, one of the ends of which is introduced into the neck, where it is fixed by a little of the composition used in priming tubes, taking good care not to close the orifice entirely. If the rocket is not to be immediately used, the rest of the match is folded into the opening of the neck, and a piece of paper pasted over it; this is called capping the rocket.

When the rocket is to be fired, a stick of light wood is adapted to it, at least nine times as long as it is, (exclusive of the pot,) to guide it and serve as a counterpoise during its flight; the thickness of this stick, at its larger end, ought to be little more than one third of the diameter of the rocket, and diminish thence to the smaller end where it is about one sixth. The thick end is cut into the form of a semicircle upon one side, for some distance, and a groove made on the other in which the rocket is lodged; notches are made at the top of the semicircular part to which the rocket is tied, just below the ligature of the pot, with thread, or brass wire; other notches are made that correspond with the neck, and

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it is also tied to them; but before the stick is finally fixed, the rocket and it are balanced upon the finger placed under the stick at the distance of four inches from the neck; if the stick is too heavy it must be shortened. Finally, an upright of wood is set into the ground a little taller than the stick of the rocket, having a large nail driven into its top with a forked head to receive the neck of the rocket, and a ring, or something of the sort, at bottom, into which the end of the stick may be passed, to keep it vertical; the rocket is then uncapped, and fired with a port fire, mounted upon a large port fire stock.

Of Serpents, Stars, and Petards, to trim Signal Rockets.

Serpents.

To make a serpent, roll a playing card, in the direction of its length, upon a former three lines in diameter, cover it with three coats of paper, the last of which is pasted; choke this case at one of its ends, and place in the neck a strand of tow and a priming of meal powder, moistened with spirits; load the case, by means of a rod, three fourths full of the following composition, and choke it anew at half its height; fill the remainder of the case with powder to make a report and close the case entirely above it. If a serpent with stars is to be made, only half the case is filled with the composition below, and the rest with the composition for stars.

Composition.

Meal gunpowder, . . .	16 parts.
Saltpetre, ...	3 do.
Sulphur, ...	2 do.
Charcoal, ...	½ do.

Serpents are placed upright in the pot, the priming down.

Stars.

Pass the several articles of the following composition through hair sieves, and mix them well; make of them a thick paste, with

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gummed spirits, that will set; form a cake of the thickness of a finger, and cut it into little cubes, or else roll it into small balls; roll them while wet in meal gunpowder, and then dry them.

Meal gunpowder, ...	5 parts.
Saltpetre, ...	16 do.
Sulphur, ...	8 do.
Antimony, ...	2 do.

Petards or Crackers.

These are small cubes of paper filled with grained gunpowder; they are wrapped with two layers of good thread, which is drawn tight in every direction; they are dipped in tar to give them more consistence; they are then pierced to the powder so as to prime them with a bit of quick match.

OF INCENDIARY FIREWORKS.

Fire Stone, (Roche à feu.)

Fire stone is a solid composition that burns slowly; it is put into shells and howitzes, intended to produce conflagration. It is composed in the following different ways:

	Sulphur.	Saltpetre.	Meal powder.	Grain powder.	Spirits of turpentine.
A composition frequently made use of,	16	4	4	3	
do. do.	28	5	4	4	
do. for particular purposes,	6	1	4		12 oz.

The sulphur is melted in a kettle, or glazed earthen vessel, over a clear charcoal fire, the saltpetre is then thrown into it, and the spirits of turpentine, if any of it is used; these articles are stirred about with a spatula, and care is taken to moderate the fire if they show a disposition to boil, because they might in that case take fire. When these are well melted and mixed, they are

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taken off the fire, and permitted to cool a little; the gunpowder is then thrown in, and the composition poured upon a cold surface, where it consolidates; it is broken into small lumps to be made use of when needed.

Incendiary Matches.

In order to make these matches, boil common slow matches, for the space of four minutes, in water, in which 20 parts of saltpetre, to six of water, has been dissolved; then dry it; cut it into pieces of two or three inches long, and dip it into fire stone in a state of fusion; before the fire stone has become solid, roll the matches in gunpowder, either grained or meal. (1500 matches of this sort will require 50 pounds of fire stone.)

These incendiary matches are better for the purpose of putting into shells and howitzes, than fire stone alone, which does not burn as well as they do.

Of Carcasses and Fire Balls to be thrown from a Mortar.

Carcasses and fire balls, are thrown from mortars in the same way as shells; their use is to light up the works in front of a besieged fortress, and to burn buildings. The difference between them is, that the carcass has bands and circles of iron that form its shell, while the fire ball is made of a sack of strong tow cloth; they are both well wrapped with cords to make them more solid.

The carcass for 12 and 10 inch mortars has six bands of iron; that for an 8 inch mortar no more than four. These bands are of an oval shape, and are fixed with clenched nails to a bottom of the shape of a segment of a sphere; then to a circular hoop placed horizontally at one third of their height; and at top to another that closes the opening.

The sacks that contain carcasses and fire balls, are of a cylindrical form, their diameter and height are equal, and are the same as that of the carcass at one third its height, they are sewed upon a circular bottom, like the woollen bags of gun cartridges.*

* The folds that might be feared from this cylindrical form, will disappear, by winding the ball with thread; besides, they cannot reach up to the largest

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The composition for carcasses and fire balls is made as follows, viz.

	Pitch.	Mutton Tallow	Rosin.	Sulphur.	Saltpetre.	Gun powder.	Charcoal.
Moist composition, . . .	18	1				30	
Dry do.			12	2½	11		1½

About 49 pounds of composition and two pounds of fine tow, are required for a carcass of 12 inches.

The materials of both these compositions (with the exception of the gunpowder) are slowly melted; they are stirred and carefully skimmed; attention must be paid to prevent them from inflaming, by keeping down the fire.

When the materials are well melted, the kettle is withdrawn from the fire; the gunpowder is then poured gently in, stirring the composition with a spatula, to make a complete mixture; the kettle is then again put over the fire; when the composition is heated, it is withdrawn, and the tow added in small quantities at a time, stirring the mixture well that it may be thoroughly incorporated.

The whole being thus amalgamated, the carcass or fire ball is made in the following manner, after having first placed the iron frame, (if it is a carcass,) in the sack.

Four cords are taken, each four lines in diameter, four feet long for the calibers of 10 and 12 inches, but only three feet for the caliber of eight inches. The middle of these four cords are laid one upon the other in the form of an eight pointed star; each end of the ropes is then fixed to a nail, and a bottom is formed in the manner of basket work, by interlacing a cord two lines in diameter, three or four times round the central point; the small cord is then tied with a knot, and the bottom of the basket completed by tying the four large cords together, with four half knots; the bottom of a sack containing the iron carcass, or of an empty sack, if a

diameter, so they will do no harm. The sacks of fire balls are an inch less in height than the caliber of the mortar, and those of carcasses four inches more.

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fire ball is to be made, is placed upon the middle of this, and the filling performed in the following manner, viz :

A sufficient quantity of the composition is taken from the kettle to fill the empty carcass or sack three or four inches high ; a few loaded grenades, with the fuse down, or a howitz placed in the same way, are laid upon this first layer ; the filling is continued to the top, putting the composition and grenades, in alternate layers ; when it is done, the sack is tied with twine. In order to tie up the fire ball in its cord net, the cords are raised from their nails, over the sack, and tied in such a way as to suspend it about the height of a man's head, and to permit it to be easily turned round ; an artificer fixes the end of the small cord to one of the larger ones, at the distance of $1\frac{1}{2}$ inches from the bottom, he makes a half knot upon this, and carries the small cord round to the others, to which he ties it in the same way, forming a spiral round the ball ; the large cords are kept regularly stretched in such a way that each turn of the spiral may be $1\frac{1}{2}$ inches from that beneath it ; when the spiral has reached the top of the ball, he unites the small cord (called the traverse) with the ends of the four others, (called uprights ;) he divides the latter into two parcels, and forms a loop of them, through which a lever may be passed for the convenience of carrying it. At two or three inches from the upper end, and upon two sides diametrically opposite to each other, two pins of hard dry wood, well greased, are driven in ; these pins are six inches in length, one in diameter at the head, and half an inch at the point ; they must be inclined in such a way as to meet in the axis of the fire ball at about half its height.

The carcass or fire ball, when finished, is dipped into a composition made of

32	parts	of pitch.
16	do.	turpentine.
8	do.	rosin.
6	do.	linseed oil.
1	do.	mutton tallow.

When it is taken from this composition, it is dipped in cold water, brought into shape with the hand, and then dried.

Carcasses and Fire Balls are primed before they are used, by

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drawing out the pins, and filling the holes with the composition for the fuses of shells.

Incendiary Balls, or Fire Balls to be thrown from Cannon or by hand.

parts of	Powder.	Saltpetre	Sulphur.	Rosin.	Tallow.	Alum.	Antimony
Ordinary composition, moistened with spirits and linseed oil. *Meal*	4	4	3½	¾			
Another composition. *Grained*	8	8	24		4	2	1

These sorts of balls are employed, chiefly, in besieged fortresses to light up the enemy's works; in order to burn ships, hollow balls, filled with incendiary matter, and red hot shot, are preferable.

In order to use the first composition, reduce the materials, after they have been well mixed, into a paste, by moistening them with good brandy or other spirits, in which gum arabic and camphor have been dissolved; leave it a few hours to dry; then moisten it with linseed oil, and make it up into balls, a little less than the caliber of the guns from which they are to be fired, or weighing about 4 pounds if they are to be thrown by hand; they are tied up in cloth, and steeped in a bath of pitch in the same way as carcasses; they are covered a second time with cloth and dipped in the same way; if they are to be fired from guns, they are enveloped with a net of iron wire, to prevent them from being broken by the action of the charge. In order to fire with these balls, they are put down over a small charge without ramming.

Two holes are made in them in the same way as in carcasses and fire balls, and they are primed in the same manner.

In employing the second composition, the materials (with the exception of the powder, which is put in after,) must be melted. It is then poured into wooden moulds, of two pieces, that are greased on the inside; the ball is taken from the mould when cool, and wrapped up in cloth or in tow; it is dipped in melted pitch; when it is to be used, holes are made in it with a gimblet, and it is primed like the others.

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Pitched Tourteaux and Fascines.

Tourteaux, are used at night to illuminate the passages of rivers and defiles, they are placed in portable lanthorns. Pitched Fascines are chiefly used to light up the works of the besieger when he approaches the covered way, and to burn the gabions and fascines with which he constructs his passage of the ditch; *tourteaux* are also used for this last purpose.

Tourteaux are made of old cords or pieces of match which are beaten with mallets and untwisted a little, to make them imbibe the composition more readily; they are then cut into pieces about 5 feet in length, and each is gently intertwined to form a circle of 5 or 6 inches of external diameter; observing to make a hole in the middle for the passage of the point of the lanthorn. The *tourteaux* thus formed are thrown into a composition made of

24 parts of pitch.
12 do. of turpentine.
6 do. of rosin.
4 do. of mutton tallow.
1 do. of linseed oil.
1 do. of Venice turpentine.

They are boiled from 10 to 15 minutes in this composition, and laid to cool upon a wet plank; they are a second time dipped into the composition, and thrown into cold water, to give them again, by hand, the circular figure they will probably have lost; they are then powdered with flour of sulphur, and dried in the shade.

Pitched Fascines are made of dry twigs, (vine shoots are the best,) about 18 inches long; they are tied in bundles of 4 or 5 inches in diameter with cord or iron wire; they are boiled in the same composition as the tourteaux, and thrown into water to cool.

Powder Bags.

Powder bags are little sacks that contain about 4 pounds of powder, and are thrown upon troops mounting to the assault. They

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are chiefly employed in besieged fortresses. They are made of strong cloth, and only sewed upon the sides; one of the ends is then tied with a string, and the bag turned, so that the ligature may be within; the powder is thrown in and rammed at each layer until it is full; the top of the bag is shut, and the large end of the fuse of a shell tied into it; the priming is put at the small end; this fuse is tied in, as tight as possible, with twine, and the outside of the bag pitched.

Powder Barrel.

A powder barrel is a common barrel filled with powder, to roll from the top of a breach, or upon the head of a sap from the glacis. The barrel contains from 100 to 200 pounds of powder, and is covered with a cloth; a hole is made at each end, in which a fuse may be fixed, of such a size that the fire may be communicated to the powder, at the moment when the barrel, rolled from the top of the breach, is met by the troops mounting to the assault.

Thundering Barrel.

This is employed for the same purposes as the preceding one, or to light up the works of the besieger at the foot of the glacis. It has the same dimensions with the other, but has no cover; it is filled with chips dipped into the composition of tourteaux; these are arranged in layers, between each of which meal powder is strewn, and grenades put, furnished with their fuses, or with pieces of musket barrels; the first and last layers are made with tow boiled in the composition of carcasses; the barrel being filled, it is closed and primed in the same way as the powder barrel, with a bomb fuse at each end; holes are made along the barrel, from distance to distance, to assist the combustion.

Burning, or Illuminating Barrel.

This barrel only differs from the former in having no grenades, and when it is placed upon a glacis, to light up or discover the works of the besieger, it has a fuse in only one of its ends.

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Of the Petard.

The petard is a hollow piece of brass, of the figure of a truncated cone, and of arbitrary dimensions; (it is, however, usually 8 inches high, and 9½ in diameter at the base, the metal is 10 lines thick at top and 6 at bottom;) it is open at the large end, and the small end, which is rounded, is pierced with a hole, in which is placed a brass fuse* filled with composition; it is furnished with 4 trunnions (1½ inches by 1,) to receive the iron staples, that attach it to an oaken plank 18 inches square, and 2½ inches thick, reinforced below by 2 iron bands, in the form of a cross, nailed and dovetailed in; it has two iron handles to carry it by, and hook it to a screw driven into the gate intended to be broken; it is filled with gunpowder. The use of the petard is to break down the gates and barriers of small towns, and even thin walls, by hanging it against them, and setting fire to the fuse.†

In order to load the petard, it is filled with powder to within 3 inches of the bottom; some folds of cartridge paper are then put in, and a bed of tow well rammed; it is finished with a hot cement made of one part of rosin, and two parts of ground brick; a plate of iron 4 or 5 lines thick is set into this, that fits the inside of the petard at that part; it is furnished with three iron points to be driven into the plank. A petard ready for use weighs 85 pounds, and contains 9 pounds of powder.

Torches or Flambeaux.

Torches or flambeaux are made use of to give light during night marches; they ought to burn as long as the march continues.

Boil, in a mixture of equal parts of water and saltpetre, old cords, or old match well cleaned and untwisted; take them out and dry them; cut them into bits of 4½ feet in length; tie 4 of these pieces with twine to a cylindrical piece of wood, of the same length, and an inch in diameter, so that the whole together may be from 2 to

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* For want of a brazen fuse, it may be primed with a bomb fuse, or a slow match.

† The petard may be replaced by a shell filled with powder.

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2½ inches thick; dip this torch into a liquid paste made of equal parts of meal powder and sulphur, mixed together with gummed spirits; fill the intervals of the pieces of cordage with a paste made of 3 parts of sulphur, and one of quick lime; dry the torch, and when it is dry turn it gently round, and pour upon it gradually the following composition.

32 parts	of Turpentine..
4	of Venice Turpentine.
32	of Beeswax.
12	of Sulphur.
6	of Camphor.

A composition may also be made simply with six parts of pitch, six of turpentine, and one of Venice Turpentine.

Torches or flambeaux may also be made without the central piece of wood.

Note. Fireworks may be kept for a long time if they are protected from the damp.

They are transported in barrels or cases, in which they are carefully packed with tow.

Cure for Burns.

It may be useful to point out here some remedies for burns, which are accidents that sometimes take place in the manufacture of fireworks: rub the burn with plaintain juice mixed with nut oil; or else with a lixivium made of quick lime, steeped in water, to which is added hemp seed, olive or linseed oil, and the white of eggs; or with this composition, melt fresh butter, skim it, and throw in turnips; stir them well, and press them at the same time to extract the juice.

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OF CASTRAMETATION.

CASTRAMETATION is the art of laying out camps; and a *Camp*, or Encampment, is the position occupied on the ground by troops as a Military Station.

In laying out camps, the two following rules must be observed, as far as the nature of the ground will permit. 1st. To make the front of the camp equal to that of the line of battle; 2d. To encamp the troops in the same order in which they are to fight. If these are attended to, the troops may sally from the camp to form themselves in order of battle in front of the colour line without confusion. (By colour line, we understand the line which forms the head of the camp, on which the tents that form the first line are pitched.)

The colour line ought to be parallel, or nearly so, to the line of battle; in regular encampments, these lines are exactly parallel and equal to each other. The camp of an army is made up of the separate encampments of the several arms that compose it. Its figure is made up of those of the separate camps, so that the size and form of the camp of the unit of force in each of them, must be known, in order to fix the length to be given to the colour line, in relation to the order of battle adopted by the general. It is by this order of battle that the chief of the staff of the army is governed in tracing the general colour line, and fixing the several places of encampment of the different arms.

We shall now describe the tents and huts, that are used to shelter troops from the weather.

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Of Tents.

A tent is a small shelter made of coarse linen cloth, supported by one or two poles, with a cross piece at top. The cloth is spread out and drawn tight towards the ground, to which it is firmly fixed by pickets. A little trench is dug around it, and the earth thrown up into a small bank, so as to guard the interior as much as possible from the effects of rain. (Pl. 10. fig. 90 and 91.)

There are two kinds of tents. 1st. The small tent called by the French *canoniere*, (fig. 90.) which contains, at most, 8 soldiers. It is 12 feet long, and 8 wide, each tent pole is $6\frac{1}{2}$ feet long, and the cross piece as much. The entrance is on the smaller straight side.

2d. The large tent, which will accommodate 16 soldiers,* or 8 horsemen, (with the furniture of their horses.) (fig. 91.) It is 20 feet long and 13 feet wide, the height of the pole, (there is but one,) $6\frac{1}{2}$ feet, and its thickness $3\frac{1}{2}$ inches. The smaller sides are usually round, and the entrance is upon one of the long sides.

Of Huts.

Troops are never hutted, unless they are to remain long in one position, during an inclement season, or when tents are not to be had. A camp of huts does not differ from one of tents, in any other respect than the substitution of one of these species of shelters for the other. The frame of a hut is composed of 4 uprights placed at the four corners of a rectangle, (fig. 92.) and connected together in pairs by two small cross pieces; on the middle of each of the less sides, another upright is placed, longer than the others, to support the roof. This frame is sometimes covered with boards, that form both the sides and the roof; it is faced at others with stout branches, or with hurdles, that are covered with a certain thickness of loam mixed with straw. They are at times made of the same dimensions as the tents, but their con-

* The large tents cannot, conveniently, hold more than 14 men, nor the small ones more than 7, but some of the soldiers are always on duty or detachment.

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struction varies with the materials, the customs of the country, and the time the camp will probably remain.

The following dimensions have often been given to huts. The posts are sunk from two to three feet into the ground, according to its tenacity, and those at the corner reach to the height of 6½ feet above it; those that are to support the ridge of the roof are 4 feet taller. They are made 16 feet wide to take in two rows of soldiers, and 22 inches in breadth is allowed for each person that is to be accommodated within; thus a hut to contain 30 men must be 16 feet wide and 27½ feet long.

In some cases, when the ground is dry, the bottom of the huts is sunk 3 feet into the earth, and they are then less exposed to the effects of violent storms.

Huts for horses are usually 25 feet wide, to take in two ranks, 3½ feet in length for each horse, and 12 or 15 feet high.

The huts of the officers are so arranged within, as to contain their servants, and often their horses.

ENCAMPMENT OF A BATTALION.

The colour line of the camp of a battalion is determined by the length of its line of battle, to which it must be about equal; in order that the battalion, when it leaves its tents, may on the one hand have room to form, and on the other may cover its camp.

The front of this camp then, must be traced in conformity to the habitual formation, which in this country is two deep, and to the fact that a man in the ranks occupies 22 inches. If we take, for example, one of the battalions of the present regulation, which

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* Some military men allow two feet for the front of every file when in camp, but this is wrong, for the encampment should not be longer than the front of the body it contains, drawn up in order of battle; for this reason the camp should not allow more than the regulation fixes, for the space a man should occupy in the ranks, (in France this is 18 inches.)

The calculation to find at once the front of the camp of a battalion, is easy when we consider that 3 yards is about equal to the space occupied by 5 files. I deduct nothing for the file closers, because an allowance of one file must be made for the commander of each platoon; so rigorous a precision is by no means necessary.

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has 5 companies* of 100 men each, the front will be 250 files, which, multiplied by 22 inches, will give 153 yards for the extent of the array in battle, and in consequence, of the front of the camp. In this will be comprised the interval that ought to be left between one battalion and another, because the front is always diminished by absences; this interval is usually 15 yards, but sometimes only half that distance.

The tents are arranged in files perpendicular to the colour line. Their backs are placed towards each other, with a distance of six feet between them to form streets; the files on the wings are single ones. (fig. 95. and 96.)

Each file ought to contain half a company, or in the present case 50 men, who will require 6 tents. (fig. 95.) The camp of a battalion of 5 companies will then be formed of 10 files of tents. As each tent is 12 feet long, the 10 tents in front, will occupy 40 yards, if 8 yards be added for the 4 streets of 6 feet in width, and 16 yards on the left for the interval between the battalions, there will be 64 yards to deduct from the 153 which is the front of the battalion. Eighty-nine yards, then, will be left for the 5 large streets, or more than 17 yards for each of them. If this breadth is too great, the extreme files may be at the distance of 24 yards from each end of the line of battle, instead of placing them at 8. This will diminish the breadth of the streets to 11 yards.

If the large tents are used, there will be no more than 3 in each file, every thing else will remain the same as if the tents were small, as may be seen in the camp of a battalion, (fig. 96.)

If the battalion were composed of six companies instead of five, the only difference would be the addition of one double file of tents; if the companies were enlarged, there would be one or more additional tents in each file.

If the habitual order of the battalion were 3 men in file, or in three ranks, the front would be only 100 yards, and the great streets only 7 yards each. (5 yards is quite sufficient.)

It is evident that the tracing of the front of a camp is thus reduced, to ascertaining the length occupied by the files of tents and the small

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* It would be much better to form the battalion into six companies, one of Grenadiers, one of Light Infantry, and four battalion companies.

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streets, which is a constant quantity, to which must be added the interval between the battalions; take this sum from the whole front, and divide the remainder by the number of large streets; this gives the width of each, and is the only variable dimension, besides the number of tents in each file. These will depend on the number of companies in the battalion; on the fact whether each file of tents contains a company or a half company; and whether the battalion is formed into 2 or 3 ranks.

The openings of the tents ought to be towards the large streets, in which the troops may assemble, in order to advance to the front. These streets, therefore, must not be diminished in breadth, nor must they be less than 15 feet wide, so that the company may form in them, in order of battle, and file out of them by the flank. The small tents have their opening on one of the small sides, so that their length will be in the direction of the front of the camp; it is the reverse with the large tents, whose opening is on one of their long sides.

As each file of tents contains half a company, its two sections are placed, one to the right, and the other to the left of one of the great streets, and opposite each other.

The companies of grenadiers are often weaker than those of infantry, and employ, in consequence, fewer tents. If, for example, it needs no more than 8 small ones, the flank file is completed; but that placed with the back towards the next company has only two tents, one in the first rank, the other in the last.

In general, when some of the companies are strong, and the others weak, the camp is laid out in relation to the strong ones, and vacancies are left in the files of the weaker ones.

When the companies of grenadiers are on detachment, the place they ought to occupy will remain vacant, and increase the interval between the battalions.

If the battalion were weak, for example not more than 260 men, the camp must then be by files of tents, each of which contains a company; for if there were two files of tents to each company, the great streets would be too narrow. In this case, there will be only 5 files, 2 of which are double, and 1 single.

The encampment is sometimes laid out in files, each of which contain a company, whatever may be the numerical force of the battalion; this happens when the position is narrow, and it is not

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wished to encamp in two lines, or may be done as a stratagem. It may be seen that in this general method of laying out camps, the width of the great streets is the only variable quantity ; it is, then, always easy to augment or diminish the fronts by any given quantity, if there be any reason for so doing, by dividing the increase or diminution of the front, among the streets.

The front of the Camp, of a regiment of two battalions of 500 men each, whose habitual order of formation is two deep, will then be 306 yards ; and that of a regiment of 3 battalions 459 yards. Figures 96 and 95 represent a regiment of two battalions encamped ; the first battalion is in large, the second in small tents.*

When there is an interval of 16 yards between the battalions, 24 are left between the regiments, and 32 at least between the brigades.

Observations. Events may happen, in the course of a war, which require a diminution of the front of the camp. If it be only wished to diminish the position in a small degree, it may be done by lessening the width of the great streets any given quantity, and detaching a file for every 22 inches of diminution, to act as sharpshooters, either in the front, the rear, or the flanks of the camp.

If it be wished to reduce the position one half, the front of the encampment of each unit of force may be taken of half the usual size ; in this case, the order of battle may be twice the habitual depth, and each company encamped in a single but deep row. This formation will permit a first line of half battalions to be carried hastily forward, and leave another to cover the camp ; or the two lines to be marched in echelon from the very first.

In the same circumstances, half of each battalion may encamp, facing to the rear, behind the tents of the staff, in order to defend this part of the camp. Every thing will be regulated upon this front in the same way as upon the other, and the distances of the four rows of tents of the staff diminished.

Depth of the Camp. The bells of arms must be placed in one

* It may be as well to remark, that tents of the large pattern have never been introduced into the American service. Tr.

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line, ten yards in front of the colour line, and in the prolongation of the files of tents.

The tents are placed in files, perpendicular to the colour line, and their backs are separated by small streets two yards in width. In the infantry, the non-commissioned officers of companies have not usually a separate tent, but when they have, it is placed at the extremity of one of the files.

The line of kitchens, is 10 yards in the rear of the soldiers' tents.

The serjeant majors, drummers, musicians, master workmen, and suttlers, encamp in a line 15 yards in the rear of the kitchens.

The lieutenants 15 yards behind them, opposite their respective companies.

The captains 15 yards behind the lieutenants.

The line of tents of the regimental staff, is 20 yards behind the captains' tents, and the officers are placed as follows, viz.

The colonel opposite the centre of the regiment, having the major, or lieutenant colonel, and paymaster, on his right, and the surgeon on his left; commandants of battalions, opposite the centre of their respective battalions, having on their right the adjutant-major.

The colours are placed opposite the centre of each battalion, at half the distance between the colour line and the bells of arms. A wooden frame is placed on each side to lay the colours upon after retreat beat.

The wooden frame for the arms of the picket guard, (*p*) is in front of the centre of a regiment composed of two or four battalions; on the left of the second battalion, if there are three; and on the left of single battalions. A bell of arms is given, whenever it is possible, for the arms of the picket, instead of a wooden frame.

The wooden frame for the arms of the police guard, (*g*) is in the rear, upon the line of kitchens.

There is, usually, only one camp guard in front of each regiment.*

* When it is necessary to surround a camp more completely with small posts and sentinels, a camp guard is placed in front of each battalion.

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It is placed opposite the centre, about 140 yards in front of the bells of arms, and in a little work, or redan, whose faces, making an angle of 80 degrees, are 12 yards long, and 4½ feet high.

The tents for prisoners are 2 yards behind the camp guard.

The sinks for the non-commissioned officers and soldiers are opposite the centre of each battalion, and 100 yards in front of the bells of arms; those for the officers, 30 yards in the rear of the tents of the staff.

The depth of the camp, then, from the stacks of arms to the rear of the last tents, is 121 yards; of which 26 is the depth of the files of soldiers tents, (fig. 95.) which is the only variable quantity; it would be nearly the same if large tents were used, as may be seen in fig. 96; but if each company were encamped in a single file of 12 tents, then the depth would be augmented 28 yards, being the extent of six tents and their intervals.

ENCAMPMENT OF CAVALRY.

It is easy to apply the same principles to the tracing of a camp of cavalry. It must fulfil the two conditions already laid down, and provide, besides, for placing the horses and forage. The unit of force is the squadron; it is composed of two companies, which I shall here suppose to be 60 men each, so that the squadron will be of 120 men.

A squadron of 120 men, in two ranks, gives 60 files, which, allowing 3½ feet for the front of each file, is 210 feet, or 70 yards, for the length of the order of battle. Each half company will occupy a file of four tents perpendicular to the colour line; (fig. 97.) for a large tent holds eight horsemen, and the half company is thirty men. The squadron then will be encamped in four files of four tents each; two files will be placed on the flanks, and the two others in the centre, back to back, and separated from each other by a narrow street of two yards. The four front tents, and the small street, occupy 19 yards, which, taken from 70 yards, leaves 51 for the two great streets, or 25½ for the width of each.

If there were two squadrons encamped together, there will be still only two single files of tents, and three double files.

The breadth of the great streets can never be less than 14 yards, in order that two ranks of horses may be picketed in them, and

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have an easy passage out; it follows, in consequence, that when the squadron becomes less than 40 files, the encampment must be formed in files, each of which contains a whole company; in any other way the great streets would be too narrow; in this case, then, a single squadron would have two single files of tents, and two squadrons two single files, one double, and two great streets.

The forage is piled between the tents, in the direction of the depth of the camp; for this purpose the tents are separated five yards from each other, with the exception of the two last, which are double that distance apart, that is to say, 10 yards. The pickets for the horses are placed opposite to the interval of the tents, leaving a space of from six to nine feet between them and the tents. The pickets should be three inches in diameter, and three feet high above the ground, and tied together by a cord well stretched.

The tents of the noncommissioned officers are placed five yards behind the last tents of the soldiers, their opening facing the camp.

The front of the Camp of a regiment of four squadrons, of 120 men each, and forming a total of 480 men, or 240 files, will be 280 yards. (In a cavalry camp the interval of six yards, which is left between the squadrons when drawn up in order of battle, is not allowed.)

Depth of the Camp. The bells of arms are 10 yards in front of the colour line.

The tents in files, perpendicular to the colour line, and separated by spaces to contain forage.

The kitchens, 10 yards in rear of the last tents.

The Sergeant-Majors, Trumpeters, Master-workmen, Suttlers, &c. 15 yards in the rear of the kitchens.

The Lieutenants, 15 yards behind them.

The Captains, 15 yards behind the Lieutenants.

The Staff of the Regiment, 20 yards in the rear of the Captains, the officers placed in the same way as in the Infantry.

The police guard and the prisoners at half the distance between the front and the bells of arms.

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The camp guard, 140 yards in front of the bells of arms.

The standards, between the police guard and the bells of arms.

The frame for the arms of the picket on the left of the standards in the line of the bells of arms.

The sinks for the soldiers, opposite the centre of each squadron, at the distance of 100 yards from the bells of arms, those of the officers, 30 yards in the rear of the line of the staff.

The depth of the camp, from the bells of arms to the rear of the last tents, (each half company forming a file of 4 tents,) will be 151 yards, of which 56, allowed for the files of tents of the soldiers and non-commissioned officers, is the only variable quantity; this may vary without inconvenience, as it has not, like the front, any connection with the order of battle.

MANNER OF LAYING OUT CAMPS.

The camps of battalions and squadrons are traced upon the ground with three cords, that are furnished to the troops, along with their other camp equipage; these are called the front cord, the depth cord, and the perpendicular cord.

The *Front Cord*, is equal in length, to the order of battle of the corps, and distances equal to the fronts of the tents, the great and small streets are marked upon it, by pieces of stuff of different colours. Each battalion ought to have its cord in readiness, and divided according to the extent of its front, so that by merely stretching it along the line, and placing pickets at the marks, a detailed draught of the colour line may be had upon the ground.

The *Depth Cord*, is also divided by pieces of stuff, that mark the several distances in that direction; the points of the divisions that mark the corners and middle of the tents, ought to be placed upon the axes of the files, and for that purpose, their direction must have been previously fixed by means of the perpendicular cord.

The *Perpendicular Cord*, which serves to draw perpendiculars to the front, with ease, (fig. 93.) is composed of 4 pieces of rope,

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of which 3 form an isosceles or equilateral triangle, that is divided by the fourth into two equal right angled triangles. The side *c e* of this triangle is placed upon the colour line, making the middle *m*, fall upon the line of tent poles, and a man laying hold of the ring *a* stretches the cords *a c* and *a e*; the direction *a m* is then that of a file of tents.

To Pitch a Camp.

When the equipage has arrived in front of the intended camp, each squad detaches two or three men to pitch its tents. They put together the pole and the cross-piece, and pass the cloth over the latter; then placing the end of the tent pole in the place that has previously been marked by a picket, they await the signal for raising all the tents at the same moment; this is a roll of the drum; the pole is then raised, taking care to place it perpendicularly; the cloth stretched, the pickets driven, and the drain dug.

To Decamp.

When the signal is given, the pickets must be drawn out, the pole lifted, the cords untied, and the cloth freed from the earth attached to its skirts; the tent will be struck when the roll ceases; the pole is then taken out, the cloth folded, and rolled round the pole traverse and pickets.

ENCAMPMENT OF ARTILLERY.

A Battery of Field Artillery, which is the unit of force, is composed, at most, of 27 carriages.* They are encamped in 4 ranks. (fig. 98. *p.*) There are from 82 to 94 matrosses, and 94 soldiers and non-commissioned officers of the train, with at most 150 horses. The matrosses form a small camp *c* in the rear of the carriages; the soldiers of the train, and the draught horses, form two small camps, *a*, *b*, upon the flanks.

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* See Field Equipage, vol. 1.

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For the soldiers of the train, 20 small tents are required,* which are arranged along each side of the carriages, in two single files, separated by a street 20 yards in width, (certainly not less than 14,) (fig. 98. *a b*.) There must be a distance of 24 feet between each tent in the file, so that the 8 horses of the 4 drivers in each tent, may be picketed in front of it.

Five yards is left between the poles of the carriages, in rank, so as to leave room to pass between their wheels to perform slight repairs; 14 yards, between the carriages and the tents to the right and left of them, and 7 yards from the tents to the kitchens.

The Front of the Camp of a Battery, will then be from 123 to 128 yards, viz.: 4 files of tents, 16 yards; 2 large streets, 40 yards; 2 intervals between the tents and kitchens, 14 yards; 2 intervals between the carriages and the tents, 28 yards; and the front of the rows of carriages, which will be from 25 to 30 yards, according as the last row is of 6 or 7 carriages. This front of 126 yards is the same as 6 pieces occupy in order of battle, with intervals equal to the length of the pieces manœuvring with the prolonge.

The camp of the matrosses is placed 40 yards in the rear of the last rank of carriages; it is formed of 12 small tents, (2 to each gun,) for foot artillery; they are arranged in four files of 3 tents each, 2 of which are placed back to back, separated by a small street; and the two others on the flanks, facing the first, and separated from them by great streets, 10 yards in width. They may also be placed in two single files, of 7 tents each, separated by one great street; but this increases the depth of the camp.

For horse artillery, the camp will be composed of 24 small tents, (4 to each gun,) because only 4 horsemen should be put in each; they will be arranged in 4 files of 6 tents each; each great street must be 20 yards wide; (see camp of a squadron, fig. 97.) If the tents are large, only 12 need be pitched, in 4 files of 3 tents each.

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* Only 4 mounted men are usually put in a small tent, because it must also contain the saddles and bridles, but another may be put into those of the train. If the tents were large ones, only half the number would be needed, but if it were considered proper to place the whole of the harness under cover, even these would not contain more than 4 or 5 men.

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Depth of the Camp. The Police Guard of the 1st camp is 5 yards in front of the first row of carriages or colour line.

Four rows of carriages, each 8 yards in depth, and 3 intervals of 14 yards between each of them, gives a depth of 74 yards for the park; which is much more than the depth of the camp of the men and horses of the train.

Forty yards from the rear of the park to the tents of the matrosses.

Twelve yards for the depth of a file of three tents, and two small streets, 14 yards from the tents of the matrosses to the line of the officers' tents. The depth of the camp will then be 160 yards from the front of the first tent to the rear of the last. It will be 18 yards more in a camp of horse artillery, in consequence of the increase of tents, and the interval that must be left between them for stowing forage.

The line of the bells of arms of the matrosses, will be placed 10 yards in front of their tents.

The police guard and the prisoners, will be in both camps, 5 yards in front of the tents, and in the prolongation of one of the files.

The tent of the officer of the train, is 14 yards in the rear of the last tent of one of the outer files of his camp, in the prolongation of the file, and facing it.

The kitchens of the matrosses, 7 yards to the right and left of the files of tents.

The suttler on the right flank of the camp of the matrosses, and 7 yards from their kitchens.

If there are several batteries, the staff will encamp 20 yards in the rear of the line of the artillery officers, as in the cavalry.

A battery of artillery that encamps in the rear of infantry or cavalry, ought to park with the poles turned towards the enemy, but when it marches alone, it ought then to be on its guard, and turn the muzzle of its pieces towards the enemy, for fear it may be surprized with the poles turned that way, and have no time to wheel them round into battery. It ought even to have, in some positions, a piece or two in battery, and a camp guard in its front. There are circumstances when the camp of the matrosses ought to be on the flank of the park.

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OF THE GREAT PARKS, IN ARMIES, AND IN SIEGES.

In a *Great Army*, besides the batteries and the parks of the division, there is a great park, which is the general magazine, and the arsenal of repairs of the whole artillery of the army.

This great park is divided into two parts; the first division or *Magazine Park*, comprises all that is disposable and prepared for service, ammunition, cannon, and spare carriages; the second division, or *Park of Construction*, contains the materials for making the different carriages, &c. preparing ammunition, &c.

The *Magazine Park*, or first division, is established in the rear of, and as near as possible opposite to, the centre, and at least 200 yards from the rear of the camp of the army: the spare cannon in the first line, each caliber by itself, and the heaviest to the right.

The spare artillery caissons, in one or more ranks, behind the guns of the same caliber.

The caissons of infantry cartridges, on the line with, and to the right and left of the other caissons.

The waggons, travelling forges, &c. behind the caissons.

The *Park of Construction*, is placed 400 yards from the other, either on one side of it, or in the rear, according to the nature of the ground.

The forges in the first line.

The camp of the companies of workmen, 40 yards behind the forges.

The workshops 40 yards behind them, (or else in the same line as the forges, and to the right and left of them.)

Forty yards farther back, are placed the carriages of the parks, beginning with those that carry wood and iron for repairs and construction, charcoal, cordage, wheelbarrows, &c.; then the great park-caissons carrying tools for the workmen in wood and iron, edged tools, and small stores.

At a distance of 40 yards more are the tents of the director and his assistant, with those of the officers employed in the park, but without a command. The workshops of the artificers, are 40 yards to the right or left of these, or in the rear.

Two hundred yards from the rear of the park, are placed the fireworks and the materials for making them, in depots at distances of 50 yards from each other.

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On the flanks of the park, are placed the sling carts and the floating bridges, if a separate park is not made of the latter.

Five yards are allowed between the poles of the carriages, in rank, in the park of construction, to permit them to be opened, and articles taken from them as needed; but no more than 10 feet are allowed in the magazine park. 14 yards is the distance between the rows, except those of the haquets for boats, which must have an interval of at least 30.

The sentinels must see each other, and the whole park must be beneath their view. They are usually placed at 50 paces from each other, if local circumstances do not call for another arrangement.

In sieges, the park ought to be far enough from the place to be covered from its fire; and never nearer than 3,000 yards; (see *Attack of Places*;) if the garrison be formidable, and the ground not favourable, it must be placed as far off as 4,000 yards.

The park is arranged in lines; that nearest to the place, is composed of the carriages loaded with cannon, in the order of their calibers.

The second line is composed of gun carriages, each behind its respective gun; as fast as the guns are mounted, the gun-carriages are removed into the first line, and the waggons into the second.

In the third line, the balls are piled in the order of their calibers, behind the gun-carriages of the same species, or else a small separate park is made of them; this line may be completed by the pioneers tools, placed each sort by itself.

The fourth line will be composed of finished platforms, behind the several pieces, and of the armament of the pieces in the order of the calibers.

The two other sides of the park will be formed of tumbrils, camions, and other carriages.

The park of construction, which contains wood and iron for repairs, the tools, &c. is placed 80 yards in the rear, or upon one of the sides.

The powder magazines are at least 400 yards farther off; several are placed upon the same front, at distances of about 100 yards from each other, and one at half the distance between them and the park, to serve as an *entrepot*. The first have only one entrance, it is on the side towards the park; the last has two, one

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on the side of the park, the other towards the magazines. They are usually large enough to contain 480 barrels, or 96 thousand pounds of powder, being 25 feet wide and 90 feet long. (See *Powder Magazines.*) These magazines are surrounded with a ditch about six feet wide, and of the same depth, the earth thrown inwards; beams are laid beneath the barrrels; and a small guard established near the magazines, which furnishes a sentinel at the entrance of each.

The camp of the matrosses is pitched on one side of the magazine park, at the distance of 100 yards; it is placed in the most open ground, to serve as an advanced guard to the park. There is a main guard to this camp in the same manner as in those of infantry.

The camp of the draught horses and drivers, is placed opposite to that of the matrosses, at 60 yards from the park. The horses may be arranged in files in the following way: stretch two prolonges in the direction of the depth of the camp, and at a distance of four yards from each other, tie horses to these, facing each other; at the distance of 16 yards from them, place two more prolonges in the same way; tie horses to them; and so on, every 16 yards. It will be seen, that by this arrangement, the small streets between the single prolonges are four yards wide, and that there remains 10 yards between the tails of the horses and the tents in the great streets.

The camp of the drivers is placed at the extremity of these prolonges. (*Gassendi.*)

NOTE. As the cannon, gun-carriages, and platforms, must be placed as advantageously as possible, in regard to the way that leads to the attacks; it may happen, that the flank of the park must be turned towards the place; the powder magazines are then placed on the opposite flank, the draught horses in the rear of the park, and the camp of the matrosses upon the flank towards the place.

TO LAY OUT A CAMP FOR A DIVISION OF AN ARMY.

In order to trace the camp of a division of an army, (fig. 94.) mark the direction of the colour line, and then divide it into different parts, which are the fronts of the several corps to be en-

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camped. In this division of the colour line, an account must be kept of the intervals prescribed by regulation, by the general, or by the order of battle. The interval between the camps of cavalry and infantry is 50 yards.

The batteries of artillery attached to brigades of infantry or cavalry, usually encamp in the rear of the corps to which they are attached; the batteries of reserve are placed behind the centre of the division, or sometimes in rear of the wings, according to the nature of the ground, and the orders of the general. The depth of the camps of battalions and squadrons being given, the artillery traces its camp about 150 yards in the rear of them, when the army is encamped in one line; but at a distance of only 50 yards when the camp is in two lines, and the batteries placed between them. When it is possible that the army may be compelled to fight in its camp, intervals in which the batteries may be placed, are left in the colour line.

The small park of stores is placed 40 yards behind the batteries, and as near the centre as possible.

When the battalions have artillery, the pieces are placed six feet in front of the bells of arms, in such way that when it is in battery, the line of battle of the infantry may pass six feet behind the cross bars. The caissons, their horses, and those of the guns, are placed about 80 yards in rear of the last tents.

The engineer troops, (*sappers and miners,*) are established with their park, on the same line with the artillery, and beside the park of stores.

Figure 94 represents the camp of a division, of two brigades, making twelve battalions, a regiment of cavalry upon each wing, and the artillery in the rear; a battery is supposed to be attached to the first brigade, and encamped in the rear of the first regiment; two batteries of reserve in the centre; a park of stores in the rear; and a battery of horse artillery attached to the regiment of cavalry on the left.

When the colour line is not in a straight line, and makes an angle; the draught must be begun from this angle; and an additional space left between the corps nearest the angle, that the rear of their camps may not interfere with each other.

When the camp is in two lines, either on account of the narrowness of the position, or because that is the order of battle, the

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second line is drawn 300 yards behind the head of the camp of the first; when it is possible, the battalions and squadrons are separated by intervals equal to their front, in order that those in the second line, placed opposite these intervals, may be able to march to the front. The distance between the rear of the camp of one line and the head of the next, is sometimes reduced as low as 50 yards.

Finally, the head quarters are placed 300 yards in the rear of the camp, or in a neighbouring village, not far from the centre.

Communications are established along the front of the camp, and between the two lines, when that is the order of encampment: they are 10 yards in width in flying, and 50 in permanent camps.

When there are crops upon the ground, they must be cut off, from the line of the bells of arms, as far as the last tents.

OF PRECAUTIONS TO BE TAKEN FOR THE SAFETY OF CAMPS.

To provide for the safety of camps, four sorts of guards are employed, viz. *Police Guards*, *Picket Guards*, *Camp Guards*, and *Great Guards*.

Police Guard. Each regiment furnishes one, composed of 2 sergeants, 4 corporals, 2 drummers, and 48 soldiers, commanded by a Captain, a Lieutenant, and 2d Lieutenant. This guard furnishes 1 sergeant, 2 corporals, and 14 soldiers, for the camp guard, of which we shall speak hereafter. This police guard is placed in the centre of the interval of the two battalions of the regiment, upon the line of the kitchens; it ought to maintain good order, furnish patroles, prevent any person from entering into the camp, arrest suspicious persons, and place sentinels around the regiment, viz. 3 upon the front, and 3 in the rear, at 50 paces from the last tents, one upon each flank, one before the tent of the commandant of the regiment, and one before the arms.

The *Picket Guard*, both of Infantry and Cavalry, is intended to furnish detachments for extra service; they are not kept together like the Police Guard, but should be constantly ready to take their arms at the first order, or upon the slightest alarm. The Picket Guard of a regiment is composed of a Lieutenant or 2d Lieutenant,

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3 sergeants, 6 corporals, 1 drummer, and 60 soldiers. If the picket is ordered to bivouac, it places itself 50 paces in front of the bells of arms.

Camp Guard. This guard, detailed from the Police Guard, is composed of 1 sergeant, 2 corporals, 1 drummer, and 14 soldiers; it is placed 140 yards in front of the centre of each regiment, where it raises an epaulment to cover itself. (fig. 94, 95, and 96. *r.*) This guard places two sentinels opposite to the wings of the corps, and about 80 yards in its front, and one before the arms to watch the prisoners' tents; at night, two more are added opposite to the wings, dividing the distance between the two first and the bells of arms. The Camp Guard bivouacs.

Great Guards, are established to watch all the avenues that lead to the camp: they ought to occupy the passes, villages, and other shelters, under cover of which an enemy might approach rapidly, without being seen. Guards of cavalry post themselves in open places, whence they can see, at a distance, all that passes in the country. These great guards ought to be intrenched, and have as many sentinels, and even lesser posts, as may be thought necessary. See *Field Fortification*, Intrenchments of Posts.

The distance between the grand guards and the camp varies with the nature of the ground; they should be so near that they may be readily succoured in case of a sudden attack.

Although, in general, the rear of a camp requires less care than the front or the flanks, it must, notwithstanding, be carefully guarded.

ALLOWANCE OF CAMP EQUIPAGE.

For the Infantry. A small tent for every 8 men, or a large one for every sixteen, (including non-commissioned officers and drummers,) is delivered to each company; a bell of arms for every 40 men, say if a company is 40 men or less, it must have one bell of arms; if between 40 and 80, two; if between 60 and 120, three. The number of bat-horses depends, in like manner, upon the force of the companies; 2 or 3 to each is the calculation.

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For the Cavalry. A large tent is delivered to the companies, for every eight men, or a small one for every four, including brigadiers, (corporals,) and trumpeters; and a tent for the non-commissioned officers of each company.

For both Infantry and Cavalry. There is delivered to every seven or eight men, a camp kettle, its cover, and its bag; a tin pail; a wooden bowl, with its belt; a spade, a pick-axe, an axe, a bill hook; two large coverlids in cold weather. The cavalry receive, moreover, a scythe to cut forage, a hone, a hammer, a small sledge-hammer; (these tools have leather cases fitted to be carried on the saddles;) and each company receives two picket cords, 3½ feet long, and a picket shod at both ends with iron, to each horse.

To the Staff there is delivered: to the colonel a large tent, a small one for his servants, and a marquee to hold council and receive the officers; to each lieutenant-colonel, major, or commandant of battalion, captain, adjutant-major, surgeon, a large tent and a small one.

To subalterns, a large tent and a small one, to every two; sometimes only one large tent, and a small one for their servants, is allowed to the captain and subalterns of a company, in this case the line of lieutenants' tents is omitted in laying out the camp.

The paymaster receives two large tents and one small one.

For the drum-major and musicians one tent; and the same allowance in the cavalry for the trumpet-major and veterinary surgeon.

For the suttler of each battalion or squadron, one tent.

For each master workman (tailor, shoe maker, or saddler) one tent.

For the prisoners, a tent without furniture.

And cords for laying out the camp, to each battalion or squadron.

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OF THE HEALTH OF CAMPS.

It is the first duty of every officer to attend to the preservation of the health of his soldiers; he must, in consequence, carefully guard against all those causes from which disease may originate.

We shall now treat of those contagious diseases that sometimes make great ravages among large bodies of men.

Contagious Diseases.

Those diseases are called contagious, that may be transported and communicated from one individual to another. Of these, some are *acute*, and come to a crisis in a short space of time, such as some species of fever, dysentery, small pox, &c.; others, are chronic, or of long duration, such as the itch, ringworms, &c. All are produced by a peculiar exhalation from the bodies of the sick; but the last are communicated by actual contact alone, or the immediate application of the contagious matter to the skin; while, in order to contract the first, nothing more is necessary than to approach the sick, or the focus of infection, and inhale its emanations. At a certain distance contagion no longer exists, for the air cannot long remain charged with morbific matters, nor can it carry them far; it is therefore, possible to prevent the extension of contagious diseases, by isolating and shunning their foci, and by never approaching them without great precautions.

Contagious fevers, generally known by the terms, *putrid*, *malignant*, *pestilential*, (and which are also called *camp*, *hospital*, or *jail fevers*, according to the place where the disease has originated,) are generated in low, damp, or close situations, where the air stagnates and becomes loaded with the vapours of respiration and transpiration, with the exhalations of dead or diseased carcasses, or some other putrid substance; they are generally found to break out among large bodies of men, when the food or the water is unwholesome, or when any other cause of debilitation exists.

"They are observed in camps after the rains and storms of autumn, when the atmosphere is continually damp, and at the same time warm; and particularly when troops remain a long time inactive in one position; when food and drink are scarce, or of a bad quality; when the straw on which they lie is not changed, or

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contracts humidity; or when the general precautions for preserving health and cleanliness, are entirely neglected.

"When a contagious fever once breaks out, it soon extends, propagates itself from one person to another, and if neglected in the first instance, while confined to a small number of individuals, becomes soon a general malady, a sort of epidemic, that is not confined even by the barriers of the camp: in the first instance, then, it is necessary to withdraw the sick from the camp, and interdict all communication between them and the well; to prescribe to those who are charged with the care of the sick, the greatest attention to the renewal and purification of the air,* and the preservation of cleanliness; to avoid employing clothes or bedding that have been used by the sick without taking means to free them from the seeds of infection.

"The contagion should, if possible, be confined within a narrow space, and a lazaretto formed in the rear of the camp, of tents or huts, in which the sick may be attended."

Dysentery is a contagious disease that often shows itself in camps, particularly after great fatigues, at the end of warm summers, when the provisions are damaged, and fresh vegetables are not to be had: It reqnires the same precautions that we have already detailed, but as the infection principally arises from the effluvia of the excrement of the sick, the sinks ought to be established far from all habitations, and in deep trenches, that should be daily filled with earth: It would also be well to throw quick lime into them.

The measles and small pox are two contagious disorders, whose infection may be prevented, by isolating the sick, cutting off all communication between them and persons who have not had the disorder; by washing and airing the linen, clothes, and furniture, of those who have been sick, or have attended them.

"The chronic contagious diseases are the itch, ringworms, and some other cutaneous affections of the same nature. The matter

* A well-known mode of doing this, is to place over a fire an earthen vessel into which some grains of sea salt are thrown; one or two ounces of sulphuric acid are then put in; a very penetrating vapor escapes from this mixture, spreads itself, and destroys the principle of infection.

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of contagion is more fixed in these than in the acute disorders; it can only be transmitted by actual contact, or the immediate application of it to the skin. It is to be observed that relapses may be brought on by using clothing that has touched the infected skin, so that the greatest possible precautions must be taken, when the cure is nearly complete, to purify the garments, particularly the cuffs and collars.*

Precautions to be taken.†

"In order that a camp may be healthy, it should be situated on the east side of elevated ground; on a sandy, rather than a stiff soil; and free from any thing that may interrupt the course of dry and wholesome winds; it would be well if it had shade on the south side in summer; and were sheltered on the north in winter; it should also be near a river, or running stream, and not far from woods.

"When encampments, or cantonments, in ground that is moist, marshy, and surrounded by standing pools, or where the water is bad, cannot be avoided, it is necessary that the food should be both wholesome and abundant, and for the most part animal; that the vegetables should be chosen from among cruciform and alkaline plants, (cresses, cabbages turnips, radishes, &c.)

The soldier should drink wine or beer; or if they cannot be had, mix a little vinegar with the water he drinks; he should receive, daily, a ration of brandy, (or other wholesome spirits;) he should make use of aromatic plants, infused in his drink; should take care not to remain in damp or wet clothes; should have fires made every morning and evening to counteract humidity; and in addition, the troops should be kept in constant exercise."

To preserve the health of a camp, the choice of a good position is not alone sufficient; strict attention must, in addition, be paid to cleanliness, to a good regimen, to the removal of sources of infection, and of every thing that would have a tendency to charge the

* Course delivered to the pupils of *l'Ecole de Mars.*

† *Dictionnaire des Sciences Medicales.*

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atmosphere with putrid exhalations. Negligence, in these respects, produces a greater waste of life than the most bloody engagements.

The shambles should not be within the camp, and precautions must be taken to inter the blood and the intestines; earth must be thrown into the sinks, when they are half filled, and new ones dug; the precautions against infection, that we have already described, must be attended to.

Care must be taken to air the tents or huts; to expose the straw on which the soldiers sleep to the action of the atmosphere daily, and to renew it as often as possible.

In warm weather, the soldiers should be induced to bathe; the proper time for this is either early in the morning, or after sunset.

The soldiers must be prevented from eating unripe fruit, because it will cause fever, and more especially, dysenteries.

Fresh vegetables have a tendency to prevent putrid maladies.

When the water for drinking is thick or muddy, it may be purified by filtering it through fascines, supported by pickets, and covered with sand; its tendency to putrify is prevented by mixing a little vinegar with it, or a few drops of sulphuric acid, (oil of vitriol.)

It is to be remarked, that woollen clothes readily absorb and retain moisture, dew, and morbific miasmata; on this account, the dress of the soldiers should be kept dry and clean, by exposing them frequently to the sun, and by beating them from time to time. These precautions are still more necessary, to be taken with their linen, and those parts of their dress that are applied immediately to the skin,

One of the best means of preserving the strength and the health of troops, is to keep them in a state of continual activity; exercise is absolutely necessary to health, and more particularly so in moist and marshy countries, where the atmosphere has a constant tendency to cause debility; experience also has shown the danger of passing at once to inactivity after long marches, or other great fatigues.

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OF THE PRESERVATION OF SMALL ARMS.

A well-polished musket is easily kept in order; nothing more is necessary than to wipe it, after it has been used, with a dry cloth, or to moisten the cloth with oil when rust is to be removed. In order to make the parts of the lock play easily, the lower part of the hammer and the beak of the main spring are moistened with a little oil.

It is a difficult task to teach a soldier to take his musket to pieces, and put it together again, as carefully as he ought; he should, therefore, never be permitted to separate it entirely; he should do no more than remove the furniture, and separate the lock and the barrel from the wood, and the cock from the lock. The several other pieces should then be wiped without being separated; this may easily be done if the piece is in good order.

In order to cleanse those pieces which are rusted, they must be rubbed with a piece of soft wood dipped in emery and oil; for want of emery, brick pulverized and passed through a fine sieve, also moistened with oil, may be used; the soldier should be forbidden to use pounded stone or sand on any account. When the barrel is rubbed to clean it, it must be supported directly opposite to the place where the friction is applied, because it might be bent if supported only at the two extremities.

After the iron pieces have been cleansed, they should be wiped, with a cloth dipped in oil, in such a way as to retain a little of its grease. The pieces of brass are cleansed with tripoli, or with brick pounded and mixed with vinegar, but must not be oiled, or they would become oxidated.

To take a lock to pieces, with a common screw driver, when it is to be entirely cleansed, this order is followed: take off first the sear spring, then the sear, the bridle, the tumbler, the cock, the main spring, the hammer, the hammer spring, and last the pan. It is put together by inverting the same order; a drop of oil is previously put into each screw hole; and some upon the moveable arms of the springs, and the beak of the tumbler, after it is put together.

Observations. A gun may be spoiled if it be ill put together; a single screw, driven too far, may increase the friction so as to

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diminish the action of the springs; if it be the hammer screw, for instance, then this rubs against the side of the barrel at the touch-hole, and does not fly open. Sometimes it happens that the soldiers think the main spring is too strong, and heat it red hot, which destroys its action; the cock, after this, no longer falls with force enough against the hammer to strike fire, or to open the pan.

After arms have been repaired, the officers, whose duty it is to examine and receive them, ought to ascertain particularly:

1. Whether the cock is steady at *half-cock*, by attempting to draw the trigger in this situation; if the beak of the sear does not fit into the cavity of the tumbler, the cock will fall.

2. Whether the parts of the lock move without rubbing; if the tempering has been well executed; if this is the case the file ought not to touch the parts that are not heated after being tempered, and they ought to strike fire with flint. (These pieces are the *tumbler*, the *bridle*, the *sear*, the *cock-pin*, and the face of the *hammer*.)

3. By making the parts of the lock play, whether the springs are strong and well put together; particularly, whether the cock strikes fairly upon the hammer so as to open the pan, and whether it strikes fire well or not.

4. Whether the bayonet can be easily fixed and unfixed, and whether the sight is correctly placed in the perpendicular plane of the line of fire.

They ought also to ascertain that the screws fit their holes, and that their threads are good; that, forbidden modes of repair have not been used in welding or soldering pieces upon the old parts where they ought to have been replaced by new ones. The pieces, when the repairs of this kind are forbidden, and the hammer, the tumbler, the cock, and the screw of the breach.

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CONVENTIONAL AND EXPERIMENTAL RESULTS.

A foot soldier occupies 22 inches in rank.*

When he has no knapsack, he occupies, in file, two feet, including an interval of a foot between the two ranks, (this interval is reckoned from the stomach of one man to the knapsack of his file leader.)

In one minute he marches 210 feet, at the American regulation step of 28 inches, of which 90 are taken in a minute.

In the French service, the ordinary step is two feet, (French,) and the rate, 76 a minute; with this the soldier advances 152 feet a minute; he advances with the route step 170 or 180 feet a minute, the rate being 90 steps in that time; (in roads spoiled by rain, in heavy sands, or among mountains, the rate of the French route step is 76 per minute.)

The quick step in the French service is at the rate of 100 steps a minute, the soldier advances with it 200 feet, and 240 feet with the charging step, whose rate is 120 steps in that space of time.

The length of step in the British service is 30 inches, the quick step is at the rate of 108 paces a minute, or 270 feet, and the ordinary step 75 a minute, or 187½ feet.

A Horse occupies from 3¼ to 3½ feet in rank.
do do 9 feet in file.
do marches 425 yards, or steps, in 4½ minutes.
do trots . do in 2 minutes, 3 seconds.
do gallops do in 1 do.
do carries 200 pounds 30 miles a day.
do draws 12 cwt. in mountainous ground, or 15 in horizon-

* In France, the regulation is 18 inches, or 19 in. 1 1-2 lines of our measure.

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tal ground. If he carry a man, he is not expected to draw more than the half.

The length of a field-piece, or caisson, &c. drawn by four horses, two abreast, is 32 feet; a horse in harness occupies 10 feet.

It takes an hour to arrange 300 carriages in file, and they will occupy a length of 3,600 yards at least. In general, to estimate the length of a column, 12 yards must be counted for each carriage, including the interval of a yard between each.

A corps of 30,000 men in column of march, will, with its batteries, occupy about 5 miles; in this the parks and baggage are not included.

500 barrow-fulls contain 432 cubic feet of earth. A man may, in a day in summer, carry this quantity 20 yards up a slope, or 30 on level ground; but to do this he must be active and in full health; he will, in ordinary cases, carry no more than 360 cubic feet.

In earth that is easily broken, a man may, in one day, raise, and load upon a barrow, 432 cubic feet. If the ground is more difficult to move, the number of diggers must be augmented, in order that they may supply the barrow-men.

A man takes 7 days to make 6 running feet of intrenchment, of the ordinary profile.

Ammunition bread is made of $\frac{3}{4}$ wheat, and $\frac{1}{4}$ rye of good quality.

A sack of grain weighing 200 pounds, gives 175 rations of bread, weighing each $1\frac{1}{2}$ pounds, and allowing 15 per cent. for bran; the same quantity will make 180 rations, if the bran is not separated. (200 pounds of flour take 118 of water.)

A cord of wood is required to bake 20 sacks of flour weighing 200 pounds each.

When in the field, in order to preserve the bread, one fourth, one half, or even the whole of it is twice baked.

Biscuit is made of fine wheaten flour; two hundred pounds of flour give 152 rations of $1\frac{1}{4}$ pounds, or 171 pounds of biscuit.

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SPECIFIC GRAVITIES.

In relation to an equal bulk of rain water represented by unit. A cubic foot of water weighs 62½ pounds, avoirdupois.*

Solids.

Brass,	7.829
Copper,	9.257
Clay,	1.929
Flint, (*transparent.*)	2.741
Gold, (*pure or assay.*)	19.258
Gunpowder,	0.945
Iron, (*wrought.*)	8.286
do (*cast.*)	7.114
Lead,	11.828
Marble,	2.700
Mercury,	13.593
Nitre,	1.900
Plaster *of Paris*,	1.228
Platina,	19.500
Sea coal,	1.240
Silver, (*pure.*)	11.091
Sulphur,	1.800
Tin, (*pure.*)	7.320
Wood, Cedar,	0.613
Green oak,	1.143
Seasoned oak,	0.857
White ash,	0.600
Poplar,	0.371
Yellow pine,	0.550
White do.	0,498
Zinc,	7.190

* The weight of a cubic foot of water, being 62 1-2 pounds, the weight of a cubic foot of any other substance may be obtained by multiplying the number given in this table, as the specific gravity by 62 1-2. For example, the specific gravity of cast iron is given as 7.114, which means that iron weighs 7 times, and $\frac{114}{1000}$ of a time as much as water; and multiply this by 62 1-2 gives 441 pounds, $\frac{62\frac{1}{2}}{1000}$ for the weight of a cubic foot of cast iron.

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Fluids.

Atmospheric Air, - - - -	0.001¼
Linseed oil, - - - -	0.932
Rectified spirits of wine, - -	0.866
Vinegar, - - - -	1.011
Water, (*Rain*,) - - -	1
do. (*Distilled*,) - - -	0.993
do. (*Sea*,) - - -	1.030
Wine, of Bourdeaux, - -	0.993

WEIGHTS AND MEASURES.

English Measures.

The foot used in the United States is divided into 12 inches.* (It is therefore equal to 11¼ inches French measure.)

The yard = 3 feet.
The fathom = 6 feet.
The pole or rod = 5½ yards.
The chain, = 4 poles, or 22 yards.
The mile, = 80 chains, or 1760 yards, (825 toises, French.)

Sixty-nine and a half statute miles are equal to a degree of the Meridian.

An acre is 10 chains in length by one in breadth, or 10 square chains, which makes it 4840 square yards.

1 Gallon, (Dry measure,)	=	8 pints.
1 Peck,	=	2 gallons.
1 Bushel,	=	4 pecks.
1 Quarter,	=	8 bushels.
A Gallon, (Dry measure,)	=	168⅜ cubic inches.

* There is no determinate mode of dividing the English inch. Mathematicians speak of its decimal parts, while working mechanics commonly use the binary division into halfs, fourths, eights, &c.; in several parts of the work, where a strict correctness was not needed, I have retained the French division into lines or twelfths of an inch. Tr.

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A Gallon, (Wine measure,) = 251 cubic inches.
A Barrel, = 32 gallons.
The cord of wood is 8 feet long, 4 feet high, and 4 feet thick.

French Measure.

The foot is divided into 12 inches, the inch into 12 lines, the line into 12 points. (It is about equal to 12⅔ inches, English measure.)

The Ell, = 3 feet 8 inches.
The Toise, = 6 feet, (6 feet 4⅘ inches, English.)
The Perch, = 22 feet.
The Arpent, = 100 square perches.

The Paris Boisseau, is 10 inches high, and its base is a square whose sides are 8 inches.

The muid (a measure of grain) contains 144 boisseaux.

The muid (a wine measure) contains 288 pints. (The French pint is not far from double the size of the English.)

The cord of wood is 8 feet long, 4 feet high, and 4 feet thick.

English Weights.

The avoirdupoise pound, (used in the United States,) is divided into 16 ounces, the ounce into 16 drams. (The Troy pound is only 12 ounces, each of which is divided into 20 pennyweights, and by the apothecaries into 8 drams.)

The Quintal, or Hundred Weight, is 112 pounds, and is divided into 4 quarters of 28 pounds each.

A Ton is 20 cwt.

French Weights.

The pound is divided into 2 marks, the mark into 8 ounces, the ounce into 8 gros, the gros into 3 pennyweights, the pennyweight into 24 grains. (The ounce avoirdupoise, is equal to 533⅓ French grains.)

The Quintal is 100 pounds.

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Proportion between these Weights—100 French pounds, (*poids de marc*,) is equal to 107.82 pounds, avoirdupoise, and 100 pounds avoirdupoise is equal to 92.76 pounds, French.

Comparison of English Weights and Measures, with those of the principal Nations of Europe.

	Parts		Parts
The English foot being divided into	1000	The English pound being divided into	100
The French foot is equal to	1068	The French pound is	107.82
The foot of Amsterdam, to	942	The pound of Amsterdam,	93
do. Rhynland,	1033	do. Rhynland,	96
do. Antwerp,	946	do. Antwerp,	98
do. Bavaria,	954		
do. Vienna,	1053	do. Vienna,	83
do. Madrid,	1001	do. Madrid,	99
do. Naples,	861		

Mode of estimating distances in the following countries, estimated in English yards.

England,	statute mile,		1760 yds.
	Three miles make one league.		
France,	common league 25 to a degree, (2280 toises,)		4864
Germany,	short mile, (*lieue commune*,)		6859
Italy,	mile,		2025
Poland,	short mile,		6075
Prussia,	mile,		8468
Russia,	werst,		1167
Spain,	league,	common of 8000 varas,	7416
		legal of 5000 do.	4635
Sweden,	mile,		11700
Turkey,	berri,		1826

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METRICAL OR NEW FRENCH SYSTEM OF WEIGHTS AND MEASURES.

The *Metre*, which is the base of the system, is the ten millionth part of the distance between the pole and the equator, reckoned on the meridian of Paris. What distinguishes this system from all others, is, that the measures, whether of length or capacity, and the weights, have each a connection with the other, and an immediate relation to the size of the terrestrial spheroid.

The Metre is the unit of lineal measure, it is equal to 36.9413 inches, of the French foot, (3 ft. 0 in. 11.3 lin.) or 39.383 in. English measure.

The Decametre is	10 metres.
The Hectometre	100 do.
The Kilometre	1000 do.
The Myriametre . . .	10,000 do.
The Decimetre	$\frac{1}{10}$ of the metre.
The Centimetre	$\frac{1}{100}$ do.
The Millimetre	$\frac{1}{1000}$ do.

Superficial Measures.

The Are is the unit of surface, it is the square of the decametre, or 100 square metres, a decare is 10 ares, a hectare 100 ares, the deciare $\frac{1}{10}$th of an are, the centiare $\frac{1}{100}$ of the same.

Measures of Capacity.

The Litre, which is the unit, is the cube of the decimetre. The decalitre is equal to 10 litres, &c., the decilitre $\frac{1}{10}$th of a litre, &c.

The Stere, for firewood, is a cubic metre, this supposes the sticks to be cut of the length of the metre.

Weights.

The Gramme is the unit of weight, and is equal to the weight of a cubic centimetre of pure water; it weighs 18.84 grs. (*French.*) The decagramme is 10 grammes. The kylogramme is the weight of a cubic decimetre of water, and

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equal to 1000 grammes, (2 lbs. 5 gros. 49 grs. *French.*) The decigramme is $\frac{1}{10}$th of a gramme. The quintal is equal to 4.89 myriagrammes.

NOTE. It will be seen, that the names of the different measures in the ascending decimal scale, are made by prefixing the words, *deca*, *hecto*, *kilo*, *myria*, to the name of the unit of measure; and in the descending decimal scale by the prefixes, *deci*, *centi*, *milli*.

The franc is the unit of money, it is a piece of silver that weighs five grains, and is divided into decimes and centimes: its value is that of the livre tournois, as 81 to 80.

END OF THE SECOND VOLUME.

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